XCM524 Series

ETR2428-003

600mA Synchronous Step-Down DC/DC Converter + 500mA LDO
with Delay Function Voltage Detector

■GENERAL DESCRIPTION

The XCM524 series is a multi combination module IC which comprises of a 600mA driver transistor built-in synchronous step–down DC/DC converter and a high speed, high current LDO regulator with voltage detector function. The device is housed in small USP-12B01 package which is ideally suited for space conscious applications. The DC/DC converter and the LDO blocks are isolated in the package so that noise interference from the DC/DC to the LDO regulator is minimal.
The DC/DC converter block with a built-in 0.42Ω P-channel MOS driver transistor and 0.52Ω N-channel MOS switching transistor, designed to allow the use of ceramic capacitors. The DC/DC enables a high efficiency, stable power supply with an output current of 600mA to be configured using only a coil and two capacitors connected externally.
The LDO regulator block is precise, low noise, high ripple rejection, low dropout positive voltage regulators with built-in voltage detector. The LDO is also compatible with low ESR ceramic output capacitors. Good output stability is maintained during load fluctuations due to its excellent transient response. The current limiter's fold back circuit also operates as a short circuit protection for the output current.
The voltage detector block of the contains delay circuit. The delay time can be controlled by an external capacitor.
The detector monitors the input voltage of the voltage regulator.

■APPLICATIONS

●BD, DVD drives
●HDD drives
●Cameras, Video recorders
●Mobile phones, Smart phones
●Various general-purpose power supplies

■FEATURES

<DC/DC Convertor Block>

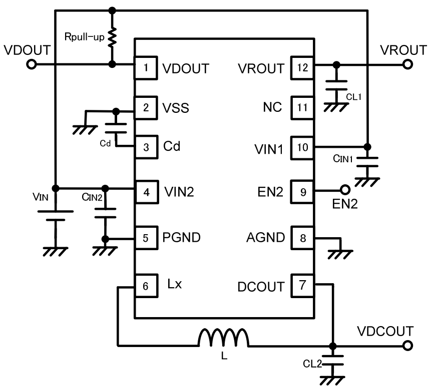
Input Voltage Range	: 2.7V ~ 6.0V
Output Voltage Options	: 0.8V ~ 4.0V (±2%)
High Efficiency	: 92% (TYP.)
Output Current	: 600mA (MAX.)
Oscillation Frequency	: 1.2MHz, 3.0MHz (±15%)
Current Limiter Circuit Built-In	: Constant Current & Latching
Control Methods	: PWM PWM/PFM Auto

*Performance depends on external components and wiring on PCB wiring.

<Regulator Block>

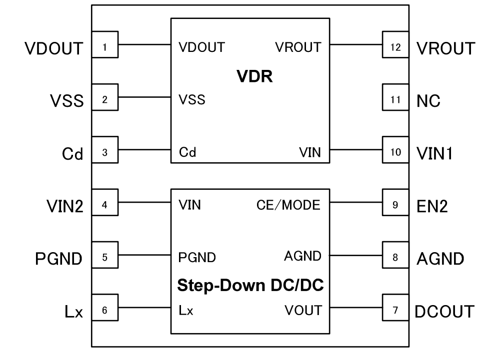
Maximum Output Current	: 500mA (Limiter 600mA TYP.) ($2.5V \leqq V_{ROUT} \leqq 4.9V$)
Dropout Voltage	: 200mV@I_{ROUT}=100mA (TYP.)
Operating Voltage Range	: 2.0V ~ 6.0V
Output Voltage Options	: 0.9V ~ 5.1V (0.1V increments, ±2%)
Detect Voltage Options	: 2.0V ~ 5.5V (0.1V increments, ±2%)
VR.VD Temperature Stability	:±100ppm/℃ (TYP.)
High Ripple Rejection	: 65dB (@10kHz)
Low ESR Capacitor	: Ceramic Capacitor
Operating Temperature Range	: -40℃ ~ +85℃
Package	: USP-12B01
Environmentally Friendly	: EU RoHS Compliant, Pb Free

■ TYPICAL APPLICATION CIRCUIT

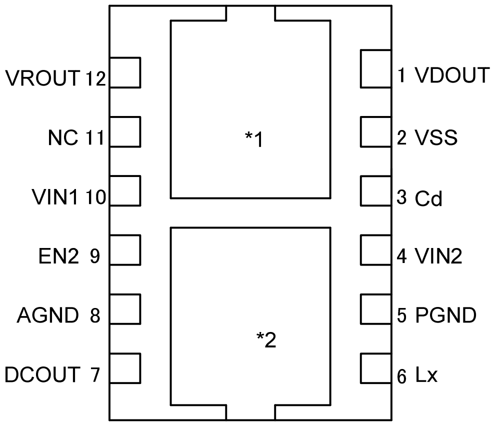


(TOP VIEW)

■PIN CONFIGURATIOIN



(TOP VIEW)



(BOTTOM VIEW)

PIN No	XCM524	VDR	DC/DC
1	V_{DOUT}	V_{DOUT}	-
2	V_{SS}	V_{SS}	-
3	Cd	Cd	-
4	V_{IN2}	-	V_{IN}
5	PGND	-	PGND
6	Lx	-	Lx
7	DCOUT	-	VOUT
8	AGND	-	AGND
9	EN2	-	CE
10	V_{IN1}	V_{IN1}	-
11	NC	-	-
12	V_{ROUT}	V_{ROUT}	-

*DC/DC Ground pin (No.5 and 8) should be short before using the IC.

* A dissipation pad on the reverse side of the package should be electrically isolated.
*1: Voltage level of the VDR's dissipation pad should be V_{SS} level.
*2: Voltage level of the DC/DC's dissipation pad should be V_{SS} level.

Care must be taken for an electrical potential of each dissipation pad so as to enhance mounting strength and heat release when the pad needs to be connected to the circuit.

■PIN ASSIGNMENT

PIN No	XCM524	FUNCTIONS
1	VDOUT	VDR Block: VD Output Voltage
2	V_{SS}	VDR Block: Ground
3	Cd	VDR Block: Delay Capacitor connection
4	V_{IN2}	DC/DC Block: Power Input
5	PGND	DC/DC Block: Power Ground
6	Lx	DC/DC Block: Switching Connection
7	DCOUT	DC/DC Block: Output Voltage
8	AGND	DC/DC Block: Analog Ground
9	EN2	DC/DC Block: ON/OFF Control
10	V_{IN1}	VDR Block: Power Input
11	NC	No Connection
12	V_{ROUT}	VDR Block: LDO Output

■PRODUCT CLASSIFICATION

●Ordering Information

XCM524A①②③④⑤-⑥ (*1) DC/DC Block: PWM fixed control
XCM524B①②③④⑤-⑥ (*1) DC/DC Block: PWM/PFM automatic switching control

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Oscillation Frequency and Options	—	See the chart below
②③	Output Voltage	—	See the chart below
④⑤-⑥	Packages Taping Type (*2)	DR-G	USP-12B01

(*1) The XCM524 series is Halogen and Antimony free as well as being fully RoHS compliant.
(*2) The device orientation is fixed in its embossed tape pocket.

●DESIGNATOR①

①	DC/DC BLOCK			VDR BLOCK		
	OSCILLATION FREQUENCY	C_L DISCHARGE	SOFT START	VD DELAY FUNCTION	VD SENSE PIN	VD OUTPUT LOGIC
A	1.2M	Not Available	Standard	Available	V_{IN}	Active Low Detect
B	3.0M	Not Available	Standard	Available	V_{IN}	Active Low Detect
C	1.2M	Available	High Speed	Available	V_{IN}	Active Low Detect
D	3.0M	Available	High Speed	Available	V_{IN}	Active Low Detect

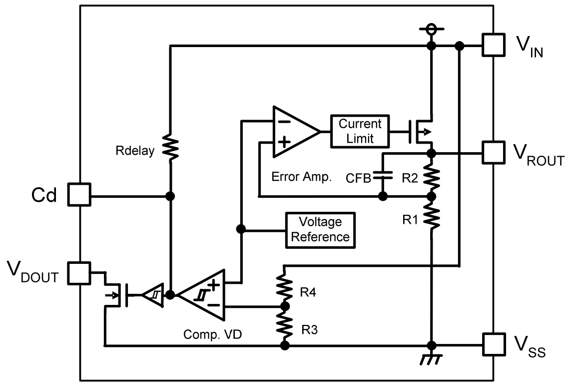
●DESIGNATOR②③

②③	V_{DCOUT}	V_{ROUT}	V_{DF}
01	1.0	3.3	3.7
02	1.2	3.3	3.7
03	1.5	3.3	3.7
04	1.8	3.3	4.2
05	3.3	1.8	2.8
06	1.8	2.5	2.8

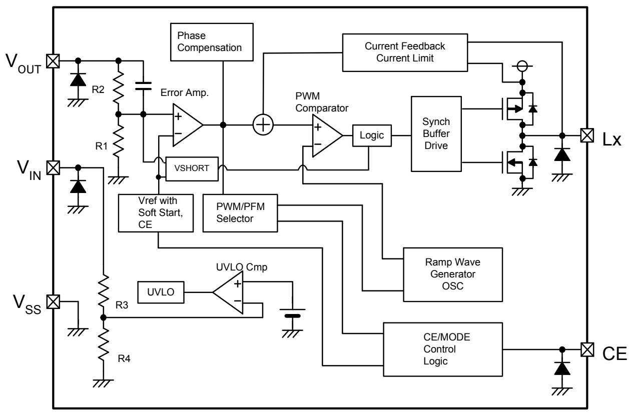
*This series are semi-custom products. For other combinations of output voltages please consult with your Torex sales contact.

■BLOCK DIAGRAMS

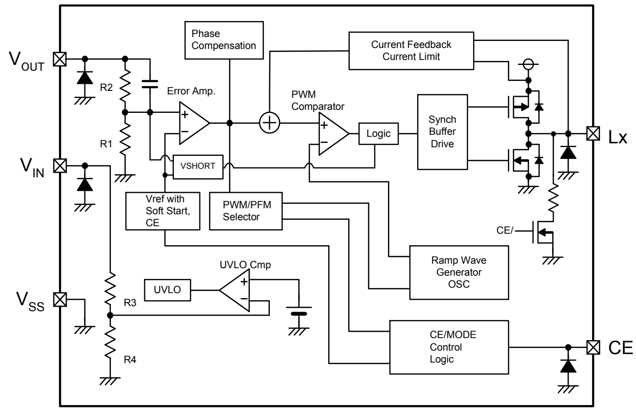
VDR



Step-Down DC/DC



Step-Down DC/DC
Available with CL Discharge, High Speed Soft-Start



* A fixed PWM control scheme because that the “CE Control Logic” outputs a low level signal to the “PWM/PFM Selector”.
* An auto PWM/PFM switching control scheme because the “CE Control Logic” outputs a high level signal to the “PWM/PFM Selector”.
*Diodes inside the circuit are an ESD protection diode and a parasitic diode.

■ABSOLUTE MAXIMUM RATINGS

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNITS
V_{IN1}Voltage		V_{IN1}	7.0	V
VROUT Current		I_{ROUT}	700(*1)	mA
VROUT Voltage		V_{ROUT}	V_{SS} - 0.3 ～ V_{IN1} + 0.3	V
VDOUT Current		I_{DOUT}	50	mA
VDOUT Voltage		V_{DOUT}	V_{SS} -0.3 ～ 7.0	V
Cd Voltage		V_{Cd}	V_{SS} - 0.3 ～ V_{IN1} + 0.3	V
VIN2 Current		V_{IN2}	-0.3 ～ 6.5	V
Lx Voltage		V_{Lx}	-0.3 ～ V_{IN2} + 0.3 ≦ 6.5	V
DCOUT Voltage		V_{DCOUT}	-0.3 ～ 6.5	V
EN2 Voltage		V_{EN2}	-0.3 ～ 6.5	V
Lx Current		I_{Lx}	±1500	mA
Power Dissipation	USP-12B01	Pd	150	mW
	USP-12B01 (PCB mounted (*2))		800 (Only 1ch operation)	
			600 (Both 2ch operation)	
Junction Temperature		Tj	125	℃
Operating Temperature Range		Topr	- 40 ～ + 85	℃
Storage Temperature Range		Tstg	- 55 ～ + 125	℃

*1 I_{ROUT}= Less than Pd / (V_{IN1}-V_{ROUT})
*2 The power dissipation figure shown is PCB mounted. Please refer to page 50 for details. Please also note that the power dissipation is for each channel.

■ELECTRICAL CHARACTERISTICS

●XCM524xx 1ch (VDR Block)

Ta=25℃

	PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
VOLTAGE REGULATOR	Output Voltage (*2, 3)	$V_{ROUT(E)}$	I_{ROUT}=30mA	×0.98	$V_{ROUT(T)}$	×1.02	V	①
	Maximum Output Current (0.9 ~ 2.4V)	$I_{ROUTMAX}$	$V_{IN1}=V_{ROUT(T)}$+2.0V	400	-	-	mA	①
	Maximum Output Current (2.5 ~ 4.9V)	$I_{ROUTMAX}$	$V_{IN1}=V_{ROUT(T)}$+2.0V Higher than $V_{ROUT(T)}$= 4.0V, V_{IN1}=6.0V	500	-	-	mA	①
	Load Regulation	$\triangle V_{ROUT}$	1mA≦I_{ROUT}≦100mA	-	15	50	mV	①
	Dropout Voltage (*4)	Vdif1	I_{ROUT}=30mA	E-1			mV	①
		Vdif2	I_{ROUT}=100mA	E-2			mV	①
	Supply Current (FV / FX / FY / FZ series)	I_{DD}	$V_{IN1}=V_{ROUT(T)}$+1.0V $V_{ROUT(T)}$≦0.9V, V_{IN1}=2.0V	-	90	145	μA	②
	Line Regulation	$\triangle V_{ROUT}$/ (V_{IN1}・V_{ROUT})	$V_{ROUT(T)}$+1.0V≦V_{IN1}≦6.0V $V_{ROUT(T)}$≦0.9V, 2.0V≦V_{IN1}≦6.0V I_{ROUT}=30mA $V_{ROUT(T)}$≦1.75V, I_{ROUT}=10mA	-	0.01	0.20	% / V	①
	Input Voltage	V_{IN1}		2.0	-	6.0	V	-
	Output Voltage Temperature Characteristics	$\triangle V_{ROUT}$/ ($\triangle$Topr・V_{ROUT})	I_{ROUT}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm /℃	①
	Ripple Rejection Rate	PSRR	V_{IN1}=[$V_{ROUT(T)}$+1.0]V+0.5Vp-pAC When $V_{ROUT(T)}$≦1.25V, V_{IN1}=2.25V+0.5Vp-pAC When $V_{ROUT(T)}$≧4.75V, V_{IN1}=5.75V+0.5Vp-pAC I_{ROUT}=50mA, f=10kHz	-	65	-	dB	③
	Current Limiter (2.4V or less)	I_{RLIMI}	$V_{IN1}=V_{ROUT(T)}$+2.0V	-	600	-	mA	①
	Current Limiter (2.5V or more)	I_{RLIM}	$V_{IN1}=V_{ROUT(T)}$+2.0V Higher than $V_{ROUT(T)}$= 4.0V, V_{IN1}=6.0V	500	600	-	mA	①
	Short-Circuit Current	I_{RSHORT}	$V_{IN1}=V_{ROUT(T)}$+2.0V Higher than $V_{ROUT(T)}$= 4.0V, V_{IN1}=6.0V	-	50	-	mA	①
VOLTAGE DETECTOR	Detect Voltage (*7, 8)	$V_{DF(E)}$		×0.98	$V_{DF(T)}$	×1.02	V	④
	Hysteresis Range (*8)	V_{HYS}		$V_{DF(T)}$ ×0.02	$V_{DF(T)}$ ×0.05	$V_{DF(T)}$ ×0.08	V	④
	Supply Current (*9)	I_{DOUT}	V_{DOUT} = 0.5V, V_{IN1} = 2.0V	3.0	6.0	-	mA	⑤
			V_{DOUT} = 0.5V, V_{IN1} = 3.0V	4.0	8.0	-	mA	⑤
			V_{DOUT} = 0.5V, V_{IN1} = 4.0V	5.0	10.0	-	mA	⑤
			V_{DOUT} = 0.5V, V_{IN1} = 5.0V	7.0	12.0	-	mA	⑤
			V_{DOUT} = 0.5V, V_{IN1} = 6.0V	10.0	15.0	-	mA	⑤
	Detect Voltage Temperature Stability	$\triangle V_{DF}$/ (Topr・V_{DF})	-40℃≦Topr≦85℃	-	±100	-	ppm /℃	④
	Delay Resistance	R_{delay}	V_{IN1}=6.0V, Cd=0V Delay Resistance =6.0V/Delay Current	300	500	700	kΩ	⑥

NOTE:

*1 : Unless otherwise stated, ($V_{IN1}=V_{ROUT(T)}$+1.0V)

*2 : $V_{ROUT(T)}$: Specified VR output voltage

*3 : $V_{ROUT(E)}$: Effective VR output voltage. Refer to the E-0 chart for values less than $V_{DF(T)}$≦1.5V.
(i.e. the VR output voltage when "$V_{ROUT(T)}$+1.0V" is provided at the VIN pin while maintaining a certain IROUT value).

*4 : Vdif={$V_{IN}1^{(*6)}$-$V_{ROUT}1^{(*5)}$}

*5 : A voltage equal to 98% of the VR output voltage whenever a stabilized VROUT1=IROUT{VROUT(T)+1.0V} is input.

*6 : $V_{IN}1$: The input voltage when VOUT1, which appears as input voltage is gradually decreased.

*7 : $V_{DF(T)}$: Specified detect voltage value

*8 : $V_{DF(E)}$: Effective detect voltage value.

*9 : VD output current is sink current at detect.

* The electrical characteristics above are when the other channel is in stop.

■ELECTRICAL CHARACTERISTICS (Continued)

●Dropout Voltage

SYMBOL	E-0		E-1		E-1	
PARAMETER / NOMINAL DETECT VOLTAGE OUTPUT VOLTAGE	OUTPUT VOLTAGE DETECT VOLTAGE (V)		DROPOUT VOLTAGE 1 (mV) (I_{OUT}=30mA) Ta=25℃		DROPOUT VOLTAGE 2 (mV) (I_{OUT}=100mA) Ta=25℃	
$V_{ROUT(T)}$ $V_{DF(T)}$	$V_{ROUT(E)}$ / $V_{DF(E)}$		Vdif1	Vdif1	Vdif2	Vdif2
	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
0.90	0.870	0.930	1050	1100	1150	1200
1.00	0.970	1.030	1000	1100	1050	1200
1.10	1.070	1.130	900	1000	950	1100
1.20	1.170	1.230	800	900	850	1000
1.30	1.270	1.330	700	800	750	900
1.40	1.370	1.430	600	700	650	800
1.50	1.470	1.530	500	600	550	700
1.60	1.568	1.632	400	500	500	600
1.70	1.666	1.734	300	400	400	500
1.80	1.764	1.836	200	300	300	400
1.90	1.862	1.938	120	150	280	380
2.00	1.960	2.040	80	120	240	350
2.10	2.058	2.142	80	120	240	330
2.20	2.156	2.244	80	120	240	330
2.30	2.254	2.346	80	120	240	310
2.40	2.352	2.448	80	120	240	310
2.50	2.450	2.550	70	100	220	290
2.60	2.548	2.652	70	100	220	290
2.70	2.646	2.754	70	100	220	290
2.80	2.744	2.856	70	100	220	270
2.90	2.842	2.958	70	100	220	270
3.00	2.940	3.060	60	90	200	270
3.10	3.038	3.162	60	90	200	250
3.20	3.136	3.264	60	90	200	250
3.30	3.234	3.366	60	90	200	250
3.40	3.332	3.468	60	90	200	250
3.50	3.430	3.570	60	90	200	250
3.60	3.528	3.672	60	90	200	250
3.70	3.626	3.774	60	90	200	250
3.80	3.724	3.876	60	90	200	250
3.90	3.822	3.978	60	90	200	250
4.00	3.920	4.080	60	80	180	230
4.10	4.018	4.182	60	80	180	230
4.20	4.116	4.284	60	80	180	230
4.30	4.214	4.386	60	80	180	230
4.40	4.312	4.488	60	80	180	230
4.50	4.410	4.590	60	80	180	230
4.60	4.508	4.692	60	80	180	230
4.70	4.606	4.794	60	80	180	230
4.80	4.704	4.896	60	80	180	230
4.90	4.802	4.998	60	80	180	230
5.00	4.900	5.100	50	70	160	210
5.10	4.998	5.202	50	70	160	210
5.20	5.096	5.304				
5.30	5.194	5.406				
5.40	5.292	5.508				
5.50	5.390	5.610				

■ELECTRICAL CHARACTERISTICS (Continued)

●XCM524xA 2ch (DC/DC Block) V_{DCOUT}=1.8V, f_{OSC}=1.2MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	V_{DCOUT}	When connected to external components, V_{IN2}=V_{EN2}=5.0V,I_{OUT2}=30mA	1.764	1.800	1.836	V	⑦
Operating Voltage Range	V_{IN2}		2.7	-	6.0	V	⑦
Maximum Output Current	$I_{OUT2MAX}$	When connected to external components, V_{IN2}=$V_{DCOUT(T)}$+2.0V,V_{EN2}=1.0V (*8)	600	-	-	mA	⑦
UVLO Voltage	V_{UVLO}	V_{EN2}=V_{IN2}, V_{DCOUT}=0V, Voltage which Lx pin holding “L” level (*1, *10)	1.00	1.40	1.78	V	⑨
Supply Current	I_{DD}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V (XCM524AA)	-	22	50	μA	⑧
		(XCM524BA)	-	15	33		
Stand-by Current	I_{STB}	V_{IN2}=5.0V,V_{EN2}=0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V	-	0	1.0	μA	⑧
Oscillation Frequency	f_{OSC}	When connected to external components, V_{IN2}=$V_{DCOUT(T)}$+2.0V,V_{EN2}=1.0V, I_{OUT1}=100mA	1020	1200	1380	kHz	⑦
PFM Switching Current	I_{PFM}	When connected to external components, V_{IN2}=$V_{DCOUT(T)}$+2.0V,V_{EN2}=V_{IN2}, I_{OUT2}=1mA (*11)	120	160	200	mA	⑦
PFM Duty Limit	DTY_{LIMIT_PFM}	V_{EN2}=V_{IN2}=(C-1) I_{OUT2}=1mA (*11)		200		%	⑦
Maximum Duty Cycle	D_{MAX}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×0.9V	100	-	-	%	⑨
Minimum Duty Cycle	D_{MIN}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V	-	-	0	%	⑨
Efficiency (*2)	EFFI	When connected to external components, V_{EN2}=V_{IN2}=$V_{DCOUT(T)}$+1.2V (*7), I_{OUT2}=100mA	-	92	-	%	⑦
Lx SW "H" ON Resistance 1	R_{LXH1}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.35	0.55	Ω	⑩
Lx SW "H" ON Resistance 2	R_{LXH2}	V_{IN2}=V_{EN2}=3.6V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.42	0.67	Ω	⑩
Lx SW "L" ON Resistance 1	R_{LXL1}	V_{IN2}=V_{EN2}=5.0V (*4)	-	0.45	0.66	Ω	−
Lx SW "L" ON Resistance 2	R_{LXL2}	V_{IN2}=V_{EN2}=3.6V (*4)	-	0.52	0.77	Ω	−
Lx SW "H" Leak Current (*5)	I_{LEAKH}	V_{IN2}=V_{DCOUT}=5.0V,V_{EN2}=0V,L_X=0V	-	0.01	1.0	μA	⑪
Lx SW "L" Leak Current (*5)	I_{LEAKL}	V_{IN2}=V_{DCOUT}=5.0V,V_{EN2}=0V,L_X=5.0V	-	0.01	1.0	μA	⑪
Current Limit (*9)	I_{LIM}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×0.9V	900	1050	1350	mA	⑫
Output Voltage Temperature Characteristics	△V_{DCOUT}/ (V_{DCOUT}·△T opr)	I_{OUT2}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm/℃	⑦
EN "H" Voltage	V_{ENH}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to “H” level (*10)	0.65	-	6.0	V	⑨
EN "L" Voltage	V_{ENL}	V_{DCOUT}=0V, Applied voltage to V_{EN2} Voltage changes Lx to “L” level (*10)	V_{SS}	-	0.25	V	⑨
EN "H" Current	I_{ENH}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
EN "L" Current	I_{ENL}	V_{IN2}=5.0V,V_{EN2}=0V,V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
Soft Start Time	t_{SS}	When connected to external components, V_{EN2}=0V→V_{IN2},I_{OUT1}=1mA	0.5	1.0	2.5	ms	⑦
Latch Time	t_{LAT}	V_{IN2}=V_{EN2}=5.0V, V_{DCOUT}=0.8×$V_{DCOUT(T)}$ Short Lx at 1Ω resistance (*6)	1.0	-	20.0	ms	⑬
Short Protection Threshold Voltage	V_{SHORT}	Sweeping V_{DCOUT}, V_{IN2}=V_{EN2}=5.0V, Short Lx at 1Ω resistance, DCOUT voltage which Lx becomes “ Lx=L ” within 1ms	0.675	0.900	1.125	V	⑬

Test conditions: Unless otherwise stated, V_{IN2}=5.0V $V_{DCOUT(T)}$= Setting voltage

NOTE:

*1: Including hysteresis width of operating voltage.
*2: EFFI = { (output voltage×output current) / (input voltage×input current) }×100
*3: ON resistance (Ω)= (V_{IN2} - Lx pin measurement voltage) / 100mA
*4: Design value
*5: When temperature is high, a current of approximately 10μA (maximum) may leak.
*6: Time until it short-circuits DCOUT with GND via 1Ω of resistor from an operational state and is set to Lx=0V from current limit pulse generating.
*7: $V_{DCOUT(T)}$+1.2V<2.7V, V_{IN2}=2.7V.
*8: When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.
*9: Current limit denotes the level of detection at peak of coil current.
*10: "H"=V_{IN2}~V_{IN2} - 1.2V, "L"=+ 0.1V ~ - 0.1V
*11: XCM524A series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control’s functions.

* The electrical characteristics above are when the other channel is in stop.

■ELECTRICAL CHARACTERISTICS (Continued)

●XCM524xB 2ch (DC/DC BLOCK) V_{DCOUT}=1.8V, f_{OSC}=3.0MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	V_{DCOUT}	When connected to external components, V_{IN2}=V_{EN2}=5.0V,I_{OUT2}=30mA	1.764	1.800	1.836	V	⑦
Operating Voltage Range	V_{IN2}		2.7	-	6.0	V	⑦
Maximum Output Current	$I_{OUT2MAX}$	When connected to external components, V_{IN2}= $V_{DCOUT(T)}$+2.0V,V_{EN1}=1.0V (*8)	600	-	-	mA	⑦
UVLO Voltage	V_{UVLO}	V_{EN2}=V_{IN2}, V_{DCOUT}=0V, Voltage which Lx pin holding "L" level (*1, *10)	1.00	1.40	1.78	V	⑨
Supply Current	I_{DD}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V (XCM524AB)	-	46	65	μA	⑧
		(XCM524BB)	-	21	35		
Stand-by Current	I_{STB}	V_{IN2}=5.0V,V_{EN2}=0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V	-	0	1.0	μA	⑧
Oscillation Frequency	f_{OSC}	When connected to external components, V_{IN2}=$V_{DCOUT(T)}$+2.0V,V_{EN2}=1.0V, I_{OUT2}=100mA	2550	3000	3450	kHz	⑦
PFM Switching Current	I_{PFM}	When connected to external components, V_{IN2}=$V_{DCOUT(T)}$+2.0V,V_{EN2}=V_{IN2}, I_{OUT2}=1mA (*11)	170	220	270	mA	⑦
PFM Duty Limit	DTY_{LIMIT_PFM}	V_{EN2}=V_{IN2}=(C-1) I_{OUT2}=1mA (*11)		200	300	%	⑦
Maximum Duty Cycle	D_{MAX}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×0.9V	100	-	-	%	⑧
Minimum Duty Cycle	D_{MIN}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×1.1V	-	-	0	%	⑧
Efficiency (*2)	EFFI	When connected to external components, V_{EN2}=V_{IN2}=$V_{DCOUT(T)}$+1.2V (*7), I_{OUT2}=100mA	-	86	-	%	⑦
Lx SW "H" ON Resistance 1	R_{LXH1}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.35	0.55	Ω	⑩
Lx SW "H" ON Resistance 2	R_{LXH2}	V_{IN2}=V_{EN2}=3.6V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.42	0.67	Ω	⑩
Lx SW "L" ON Resistance 1	R_{LXL1}	V_{IN2}=V_{EN1}=5.0V (*4)	-	0.45	0.66	Ω	―
Lx SW "L" ON Resistance 2	R_{LXL2}	V_{IN2}=V_{EN1}=3.6V (*4)	-	0.52	0.77	Ω	―
Lx SW "H" Leak Current (*5)	I_{LEAKH}	V_{IN2}=V_{DCOUT}=5.0V,V_{EN2}=0V,L_X=0V	-	0.01	1.0	μA	⑪
Lx SW "L" Leak Current (*5)	I_{LEAKL}	V_{IN2}=V_{DCOUT}=5.0V,V_{EN2}=0V,L_X=5.0V	-	0.01	1.0	μA	⑪
Current Limit (*9)	I_{LIM}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=$V_{DCOUT(T)}$×0.9V	900	1050	1350	mA	⑫
Output Voltage Temperature Characteristics	$\triangle V_{DCOUT}/(V_{DCOUT}\cdot\triangle topr)$	I_{OUT2}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm/℃	⑦
EN "H" Voltage	V_{ENH}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to "H" level (*10)	0.65	-	6.0	V	⑨
EN "L" Voltage	V_{ENL}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to "L" level (*10)	V_{SS}	-	0.25	V	⑨
EN "H" Current	I_{ENH}	V_{IN2}=V_{EN2}=5.0V, V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
EN "L" Current	I_{ENL}	V_{IN2}=5.0V, V_{EN2}=0V, V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
Soft Start Time	t_{SS}	When connected to external components, V_{EN2}=0V→V_{IN2},I_{OUT2}=1mA	0.5	0.9	2.5	ms	⑦
Latch Time	t_{LAT}	V_{IN2}=V_{EN2}=5.0V,V_{DCOUT}=0.8×$V_{DCOUT(T)}$ Short Lx at 1Ω resistance (*6)	1.0	-	20.0	ms	⑬
Short Protection Threshold Voltage	V_{SHORT}	Sweeping V_{DCOUT}, V_{IN2}=V_{EN2}=5.0V, Short Lx at 1Ω resistance, DCOUT voltage which Lx becomes " Lx=L " within 1ms	0.675	0.900	1.125	V	⑬

Test conditions: Unless otherwise stated, V_{IN2}=5.0V $V_{DCOUT(T)}$= Setting voltage

NOTE:

*1: Including hysteresis width of operating voltage.

*2: EFFI = { (output voltage×output current) / (input voltage×input current) }×100

*3: ON resistance (Ω)= (V_{IN2} - Lx pin measurement voltage) / 100mA

*4: Design value

*5: When temperature is high, a current of approximately 10μA (maximum) may leak.

*6: Time until it short-circuits DCOUT with GND via 1Ω of resistor from an operational state and is set to Lx=0V from current limit pulse generating.

*7: $V_{DCOUT(T)}$+1.2V<2.7V, V_{IN2}=2.7V.

*8: When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.

*9: Current limit denotes the level of detection at peak of coil current.

*10: "H"＝V_{IN2}～V_{IN2} - 1.2V, "L"＝+ 0.1V ～ - 0.1V

*11: XCM524A series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control's functions.

* The electrical characteristics above are when the other channel is in stop.

■ELECTRICAL CHARACTERISTICS (Continued)

●XCM524xC 2ch (DC/DC BLOCK) V_{DCOUT}=1.8V, f_{OSC}=1.2MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	V_{DCOUT}	When connected to external components, $V_{IN2}=V_{EN2}$=5.0V, I_{OUT1}=30mA	1.764	1.800	1.836	V	⑦
Operating Voltage Range	V_{IN2}		2.7	-	6.0	V	⑦
Maximum Output Current	$I_{OUT2MAX}$	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V, V_{EN2}=1.0V (*8)	600	-	-	mA	⑦
UVLO Voltage	V_{UVLO}	$V_{EN2}=V_{IN2}$, V_{DCOUT}=0V, Voltage which Lx pin holding “L” level (*1, *10)	1.00	1.40	1.78	V	⑨
Supply Current	I_{DD}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×1.1V (XCM524AC)	-	22	50	μA	⑧
		(XCM524BC)	-	15	33		
Stand-by Current	I_{STB}	V_{IN2}=5.0V, V_{EN2}=0V, $V_{DCOUT}=V_{DCOUT(T)}$×1.1V	-	0	1.0	μA	⑧
Oscillation Frequency	f_{OSC}	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V, V_{EN2}=1.0V, I_{OUT2}=100mA	1020	1200	1380	kHz	⑦
PFM Switching Current	I_{PFM}	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V, $V_{EN2}=V_{IN2}$, I_{OUT2}=1mA (*11)	120	160	200	mA	⑦
PFM Duty Limit	DTY_{LIMIT_PFM}	$V_{EN2}=V_{IN2}$=(C-1) I_{OUT2}=1mA (*11)	-	200		%	⑦
Maximum Duty Cycle	D_{MAX}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×0.9V	100	-	-	%	⑨
Minimum Duty Cycle	D_{MIN}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×1.1V	-	-	0	%	⑨
Efficiency	EFFI	When connected to external components, $V_{EN2}=V_{IN2}=V_{DCOUT(T)}$+1.2V (*7), I_{OUT2}=100mA	-	92	-	%	⑦
Lx SW "H" ON Resistance 1	R_{LXH1}	$V_{IN2}=V_{EN2}$=5.0V, V_{DCOUT}=0V, IL_X=100mA (*3)	-	0.35	0.55	Ω	⑩
Lx SW "H" ON Resistance 2	R_{LXH2}	$V_{IN2}=V_{EN2}$=3.6V, V_{DCOUT}=0V, IL_X=100mA (*3)	-	0.42	0.67	Ω	⑩
Lx SW "L" ON Resistance 1	R_{LXL1}	$V_{IN2}=V_{EN2}$=5.0V (*4)	-	0.45	0.66	Ω	−
Lx SW "L" ON Resistance 2	R_{LXL2}	$V_{IN2}=V_{EN2}$=3.6V (*4)	-	0.52	0.77	Ω	−
Lx SW "H" Leak Current (*5)	I_{LEAKH}	$V_{IN1}=V_{DCOUT}$=5.0V, V_{EN1}=0V, L_X=0V	-	0.01	1.0	μA	⑮
Current Limit (*9)	I_{LIM}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×0.9V	900	1050	1350	mA	⑫
Output Voltage Temperature Characteristics	$\triangle V_{DCOUT}/(V_{DCOUT}\cdot\triangle topr)$	I_{OUT2}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm/℃	⑦
EN "H" Voltage	V_{ENH}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to “H” level (*10)	0.65	-	6.0	V	⑨
EN "L" Voltage	V_{ENL}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to “L” level (*10)	V_{SS}	-	0.25	V	⑨
EN "H" Current	I_{ENH}	$V_{IN2}=V_{EN2}$=5.0V, V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
EN "L" Current	I_{ENL}	V_{IN2}=5.0V, V_{EN2}=0V, V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
Soft Start Time	t_{SS}	When connected to external components, V_{EN2}=0V→V_{IN2}, I_{OUT2}=1mA	-	0.25	0.40	ms	⑦
Latch Time	t_{LAT}	$V_{IN2}=V_{EN2}$=5.0V, V_{DCOUT}=0.8×$V_{DCOUT(T)}$ Short Lx at 1Ω resistance (*6)	1.0	-	20	ms	⑬
Short Protection Threshold Voltage	V_{SHORT}	Sweeping V_{DCOUT}, $V_{IN2}=V_{EN2}$=5.0V, Short Lx at 1Ω resistance, DCOUT voltage which Lx becomes “ Lx=L ” within 1ms	0.675	0.900	1.150	V	⑬
C_L Discharge	R_{DCHG}	V_{IN2}=5.0V, L_X=5.0V, V_{EN2}=0V, V_{DCOUT}=open	200	300	450	Ω	⑭

Test conditions: Unless otherwise stated, V_{IN2}=5.0V $V_{DCOUT(T)}$= Setting voltage

NOTE:

*1: Including hysteresis width of operating voltage.

*2: EFFI = { (output voltage×output current) / (input voltage×input current) }×100

*3: ON resistance (Ω)= (V_{IN2} - Lx pin measurement voltage) / 100mA

*4: Design value

*5: When temperature is high, a current of approximately 10μA (maximum) may leak.

*6: Time until it short-circuits DCOUT with GND via 1Ω of resistor from an operational state and is set to Lx=0V from current limit pulse generating.

*7: $V_{DCOUT(T)}$+1.2V<2.7V, V_{IN2}=2.7V.

*8: When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.

*9: Current limit denotes the level of detection at peak of coil current.

*10: "H"＝V_{IN2}～V_{IN2} - 1.2V, "L"＝+ 0.1V ～ - 0.1V

*11: XCM524A series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control’s functions.

* The electrical characteristics above are when the other channel is in stop.

■ELECTRICAL CHARACTERISTICS (Continued)

●XCM524xD 2ch (DC/DC BLOCK) V_{DCOUT}=1.8V, f_{OSC}=3.0MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Output Voltage	V_{DCOUT}	When connected to external components, $V_{IN2}=V_{EN2}$=5.0V,I_{OUT2}=30mA	1.764	1.800	1.836	V	⑦
Operating Voltage Range	V_{IN2}		2.7	-	6.0	V	⑦
Maximum Output Current	$I_{OUT2MAX}$	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V,V_{EN2}=1.0V (*8)	600	-	-	mA	⑦
UVLO Voltage	V_{UVLO}	$V_{EN2}=V_{IN2}$, V_{DCOUT}=0V, Voltage which Lx pin holding "L" level (*1, *10)	1.00	1.40	1.78	V	⑨
Supply Current	I_{DD}	$V_{IN2}=V_{EN2}$=5.0V,$V_{DCOUT}=V_{DCOUT(T)}$×1.1V (XCM524AD)	-	46	65	μA	⑧
		$V_{IN2}=V_{EN2}$=5.0V,$V_{DCOUT}=V_{DCOUT(T)}$×1.1V (XCM524BD)	-	21	35	μA	⑧
Stand-by Current	I_{STB}	V_{IN2}=5.0V,V_{EN2}=0V,$V_{DCOUT}=V_{DCOUT(T)}$×1.1V	-	0	1.0	μA	⑧
Oscillation Frequency	f_{OSC}	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V,V_{EN2}=1.0V, I_{OUT2}=100mA	2550	3000	3450	kHz	⑦
PFM Switching Current	I_{PFM}	When connected to external components, $V_{IN2}=V_{DCOUT(T)}$+2.0V,$V_{EN2}=V_{IN2}$, I_{OUT2}=1mA (*11)	170	220	270	mA	⑦
PFM Duty Limit	DTY_{LIMIT_PFM}	$V_{EN2}=V_{IN2}$=(C-1)I_{OUT2}=1mA (*11)	-	200	300	%	⑦
Maximum Duty Cycle	D_{MAX}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×0.9V	100	-	-	%	⑨
Minimum Duty Cycle	D_{MIN}	$V_{IN2}=V_{EN2}$=5.0V, $V_{DCOUT}=V_{DCOUT(T)}$×1.1V	-	-	0	%	⑨
Efficiency	EFFI	When connected to external components, $V_{EN2}=V_{IN2}=V_{DCOUT(T)}$+1.2V (*7), I_{OUT2}=100mA	-	86	-	%	⑦
Lx SW "H" ON Resistance 1	R_{LXH1}	$V_{IN2}=V_{EN2}$=5.0V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.35	0.55	Ω	⑩
Lx SW "H" ON Resistance 2	R_{LXH2}	$V_{IN2}=V_{EN2}$=3.6V,V_{DCOUT}=0V,IL_X=100mA (*3)	-	0.42	0.67	Ω	⑩
Lx SW "L" ON Resistance 1	R_{LXL1}	$V_{IN2}=V_{EN2}$=5.0V (*4)	-	0.45	0.66	Ω	—
Lx SW "L" ON Resistance 2	R_{LXL2}	$V_{IN2}=V_{EN2}$=3.6V (*4)	-	0.52	0.77	Ω	—
Lx SW "H" Leak Current (*5)	ILeakH	$V_{IN2}=V_{DCOUT}$=5.0V,V_{EN2}=0V,L_X=0V	-	0.01	1.0	μA	⑮
Current Limit (*9)	I_{LIM}	$V_{IN2}=V_{EN2}$=5.0V,$V_{DCOUT}=V_{DCOUT(T)}$×0.9V	900	1050	1350	mA	⑫
Output Voltage Temperature Characteristics	$\triangle V_{DCOUT}/(V_{DCOUT}\cdot\triangle topr)$	I_{OUT2}=30mA -40℃≦Topr≦85℃	-	±100	-	ppm/℃	⑦
EN "H" Voltage	V_{ENH}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to "H" level (*10)	0.65	-	6.0	V	⑨
EN "L" Voltage	V_{ENL}	V_{DCOUT}=0V, Applied voltage to V_{EN2}, Voltage changes Lx to "L" level (*10)	V_{SS}	-	0.25	V	⑨
EN "H" Current	I_{ENH}	$V_{IN2}=V_{EN2}$=5.0V,V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
EN "L" Current	I_{ENL}	V_{IN2}=5.0V,V_{EN2}=0V,V_{DCOUT}=0V	- 0.1	-	0.1	μA	⑪
Soft Start Time	t_{SS}	When connected to external components, V_{EN2}=0V→V_{IN2}, I_{OUT2}=1mA	-	0.32	0.50	ms	⑦
Latch Time	t_{LAT}	$V_{IN2}=V_{EN2}$=5.0V,V_{DCOUT}=0.8×$V_{DCOUT(T)}$ Short Lx at 1Ω resistance (*6)	1.0	-	20	ms	⑬
Short Protection Threshold Voltage	V_{SHORT}	Sweeping V_{DCOUT}, $V_{IN2}=V_{EN2}$=5.0V, Short Lx at 1Ω resistance, DCOUT voltage which Lx becomes " Lx=L " within 1ms	0.675	0.900	1.150	V	⑬
C_L Discharge	R_{DCHG}	V_{IN2}=5.0V,L_X=5.0V,V_{EN2}=0V,V_{DCOUT}=open	200	300	450	Ω	⑭

Test conditions: Unless otherwise stated, V_{IN2}=5.0V $V_{DCOUT(T)}$= Setting voltage

NOTE:

*1: Including hysteresis width of operating voltage.

*2: EFFI = { (output voltage×output current) / (input voltage×input current) }×100

*3: ON resistance (Ω)= (V_{IN2} - Lx pin measurement voltage) / 100mA

*4: Design value

*5: When temperature is high, a current of approximately 10μA (maximum) may leak.

*6: Time until it short-circuits DCOUT with GND via 1Ω of resistor from an operational state and is set to Lx=0V from current limit pulse generating.

*7: $V_{DCOUT(T)}$+1.2V<2.7V, V_{IN2}=2.7V.

*8: When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.

*9: Current limit denotes the level of detection at peak of coil current.

*10: "H"＝V_{IN2}～V_{IN2} - 1.2V, "L"＝+ 0.1V ～ - 0.1V

*11: XCM524A series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control's functions.

* The electrical characteristics above are when the other channel is in stop.

■ELECTRICAL CHARACTERISTICS (Continued)

●PFM Switching Current (I_{PFM}) by Oscillation Frequency and Output Voltage

1.2MHz (mA)

SETTING VOLTAGE	MIN.	TYP.	MAX.
$V_{DCOUT(T)} \leqq 1.2V$	140	180	240
$1.2V < V_{DCOUT(T)} \leqq 1.75V$	130	170	220
$1.8V \leqq V_{DCOUT(T)}$	120	160	200

3.0MHz (mA)

SETTING VOLTAGE	MIN.	TYP.	MAX.
$V_{DCOUT(T)} \leqq 1.2V$	190	260	350
$1.2V < V_{DCOUT(T)} \leqq 1.75V$	180	240	300
$1.8V \leqq V_{DCOUT(T)}$	170	220	270

●Measuring Maximum I_{PFM} Limit, V_{IN2} Voltage

f_{OSC}	1.2MHz	3.0MHz
(C-1)	$V_{DCOUT(T)}+0.5V$	$V_{DCOUT(T)}+1.0V$

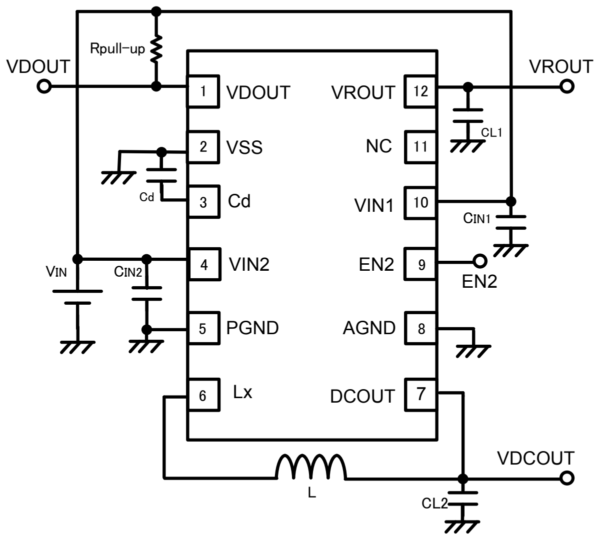
Minimum operating voltage is 2.7V

Although when $V_{DCOUT(T)}$=1.2V, f_{OSC}=1.2MHz, (C-1)=1.7V the (C-1) becomes 2.7V because of the minimum operating voltage 2.7V.

●Soft-Start Time Chart (XCM524xC/ XCM524xD Series Only)

PRODUCT SERIES	f_{OSC}	OUTPUT VOLTAGE	MIN.	TYP.	MAX.
XCM524AC	1.2MHz	$0.8V \leqq V_{DCOUT(T)} < 1.5V$	-	250 μs	400 μs
	1.2MHz	$1.5V \leqq V_{DCOUT(T)} < 1.8V$	-	320 μs	500 μs
	1.2MHz	$1.8V \leqq V_{DCOUT(T)} < 2.5V$	-	250 μs	400 μs
	1.2MHz	$2.5V \leqq V_{DCOUT(T)} \leqq 4.0V$	-	320 μs	500 μs
XCM524BC	1.2MHz	$0.8V \leqq V_{DCOUT(T)} < 2.5V$	-	250 μs	400 μs
	1.2MHz	$2.5V \leqq V_{DCOUT(T)} \leqq 4.0V$	-	320 μs	500 μs
XCM524xD	3.0MHz	$0.8V \leqq V_{DCOUT(T)} < 1.8V$	-	250 μs	400 μs
	3.0MHz	$1.8V \leqq V_{DCOUT(T)} \leqq 4.0V$	-	320 μs	500 μs

■TYPICAL APPLICATION CIRCUIT



● DC/DC BLOCK f_{OSC}=3.0MHz

C_{IN1}	:	1 μF	(Ceramic)
C_{L1}	:	1 μF	(Ceramic)
L	:	1.5 μH	(NR3015 TAIIYO YUDEN)
C_{IN2}	:	4.7 μF	(Ceramic)
C_{L2}	:	10 μF	(Ceramic)

● DC/DC BLOCK f_{OSC} =1.2MHz

C_{IN1}	:	1 μF	(Ceramic)
C_{L1}	:	1 μF	(Ceramic)
L	:	4.7 μH	(NR4018 TAIIYO YUDEN)
C_{IN2}	:	4.7 μF	(Ceramic)
C_{L2}	:	10 μF	(Ceramic)

■OPERATIONAL EXPLANATION

●Voltage Regulator BLOCK

The voltage divided by resistors R1 & R2 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET which is connected to the V_{ROUT} pin is then driven by the subsequent output signal. The output voltage at the V_{ROUT} pin is controlled & stabilized by a system of negative feedback.

●Detector Function with the XC524 Series

The series' detector function monitors the voltage divided by resistors R3 & R4, which are connected to the VROUT pin or the VIN1 pin or the VSEN pin, as well as monitoring the voltage of the internal reference voltage source via the comparator. The VDSEN pin has options. A 'High' or 'Low' signal level can be output from the VDOUT pin when the VD pin voltage level goes below the detect voltage. The VD output logic has options. As VDOUT is an open-drain N-channel output, a pull-up resistor of about 220kΩ is needed to achieve a voltage output.
Because of hysteresis at the detector function, output at the VDOUT pin will invert when the detect voltage level increases above the release voltage (105% of the detect voltage).
By connecting the Cd pin to a capacitor, the XCM524 series can apply a delay time to VDOUT voltage when releasing voltage. The delay time can be calculated from the internal resistance, Rdelay (500kΩ fixed) and the value of Cd as per the following equation.

Delay Time = Cd x Rdelay x 0.7 …(1)

Delay Time Rdelay standard : 300 ~ 700kΩ TYP : 500kΩ

Cd	DELAY TIME (TYP.)	DELAY TIME (MIN.～MAX.)
0.01μF	3.5 ms	2.1 ~ 4.9 ms
0.022μF	7.7 ms	4.62 ~ 10.8 ms
0.047μF	16.5 ms	9.87 ~ 23.0 ms
0.1μF	35 ms	21.0 ~ 49.0 ms
0.22μF	77 ms	46.2 ~ 108.0 ms
0.47μF	165 ms	98.7 ~ 230.0 ms
1μF	350 ms	210.0 ~ 490.0 ms

* The release delay time values above are calculated by using the formula (1).

*1: The release delay time is influenced by the delay capacitance Cd.

<Low ESR Capacitor>
With the XCM524 series, a stable output voltage is achievable even if used with low ESR capacitors, as a phase compensation circuit is built-in. The output capacitor (C_{L1}) should be connected as close to V_{ROUT} pin and V_{SS} pin to obtain stable phase compensation. Also, please connect an input capacitor (C_{IN1}) of 1.0μF between the V_{IN1} pin and the V_{SS} pin.

Output Capacitor Chart

V_{ROUT}	0.9 ~1.2V	1.3 ~ 1.7V	1.8 ~ 5.1V
C_{L1}	≧4.7μF	≧2.2μF	≧1.0μF

<Current Limit, Short-Circuit Protection>
The XCM524 series' fold-back circuit operates as an output current limiter and a short protection of the output pin. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. When the output pin is shorted to the V_{SS} level, current flows about 50mA.

■OPERATIONAL EXPLANATION (Continued)

●DC/DC BLOCK

The DC/DC block of the XCM524 series consists of a reference voltage source, ramp wave circuit, error amplifier, PWM comparator, phase compensation circuit, output voltage adjustment resistors, P-channel MOSFET driver transistor, N-channel MOSFET switch transistor for the synchronous switch, current limiter circuit, UVLO circuit and others. (See the block diagram above.)
The series ICs compare, using the error amplifier, the voltage of the internal voltage reference source with the feedback voltage from the DCOUT pin through split resistors, R1 and R2. Phase compensation is performed on the resulting error amplifier output, to input a signal to the PWM comparator to determine the turn-on time during PWM operation. The PWM comparator compares, in terms of voltage level, the signal from the error amplifier with the ramp wave from the ramp wave circuit, and delivers the resulting output to the buffer driver circuit to cause the Lx pin to output a switching duty cycle. This process is continuously performed to ensure stable output voltage.
The current feedback circuit monitors the P-channel MOS driver transistor current for each switching operation, and modulates the error amplifier output signal to provide multiple feedback signals. This enables a stable feedback loop even when a low ESR capacitor such as a ceramic capacitor is used ensuring stable output voltage.

<Reference Voltage Source>
The reference voltage source provides the reference voltage to ensure stable output voltage of the DC/DC converter.

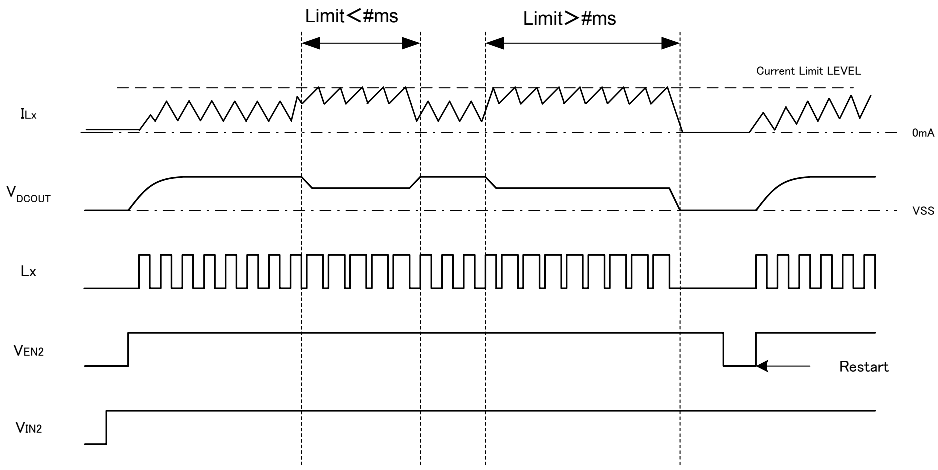
<Ramp Wave Circuit>
The ramp wave circuit determines switching frequency. The frequency is fixed internally and can be selected from 1.2MHz or 3.0MHz. Clock pulses generated in this circuit are used to produce ramp waveforms needed for PWM operation, and to synchronize all the internal circuits.

<Error Amplifier>
The error amplifier is designed to monitor output voltage. The amplifier compares the reference voltage with the feedback voltage divided by the internal split resistors, R1 and R2. When a voltage is lower than the reference voltage is fed back, the output voltage of the error amplifier increases. The gain and frequency characteristics of the error amplifier output are fixed internally to deliver an optimized signal to the mixer.

<Current Limit>
The current limiter circuit of the XCM524series monitors the current flowing through the P-channel MOS driver transistor connected to the Lx pin, and features a combination of the current limit mode and the operation suspension mode.

① When the driver current is greater than a specific level, the current limit function operates to turn off the pulses from the Lx pin at any given timing.
② When the driver transistor is turned off, the limiter circuit is then released from the current limit detection state.
③ At the next pulse, the driver transistor is turned on. However, the transistor is immediately turned off in the case of an over current state.
④ When the over current state is eliminated, the IC resumes its normal operation.

The IC waits for the over current state to end by repeating the steps ① through ③. If an over current state continues for a few ms and the above three steps are repeatedly performed, the IC performs the function of latching the OFF state of the P-channel driver transistor, and goes into operation suspension mode. Once the IC is in suspension mode, operations can be resumed by either turning the IC off via the CE/MODE pin, or by restoring power to the V_{IN2} pin. The suspension mode does not mean a complete shutdown, but a state in which pulse output is suspended; therefore, the internal circuitry remains in operation. The current limit of the XCM524 series can be set at 1050mA at typical. Besides, care must be taken when laying out the PC Board, in order to prevent miss-operation of the current limit mode. Depending on the state of the PC Board, latch time may become longer and latch operation may not work. In order to avoid the effect of noise, the board should be laid out so that input capacitors are placed as close to the IC as possible.



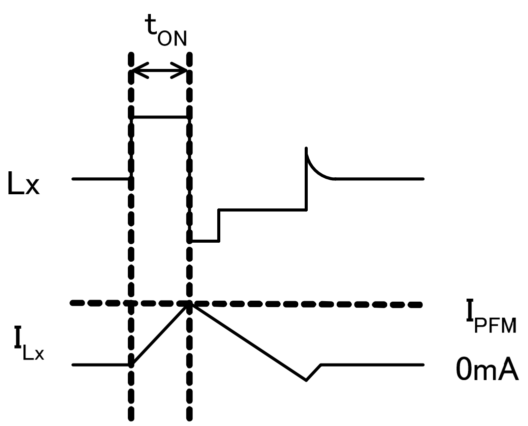
■OPERATIONAL EXPLANATION (Continued)

<Short-Circuit Protection>
The short-circuit protection circuit monitors the internal R1 and R2 divider voltage from the DCOUT pin. In case where output is accidentally shorted to the Ground and when the FB point voltage decreases less than half of the reference voltage (Vref) and a current more than the I_{LIM} flows to the driver transistor, the short-circuit protection quickly operates to turn off and to latch the P-channel MOS driver transistor. In latch state, the operation can be resumed by either turning the IC off and on via the EN2 pin, or by restoring power supply to the V_{IN2} pin.
When sharp load transient happens, a voltage drop at the DCOUT pin is propagated to FB point through C_{FB}, as a result, short circuit protection may operate in the voltage higher than 1/2 V_{OUT} voltage.

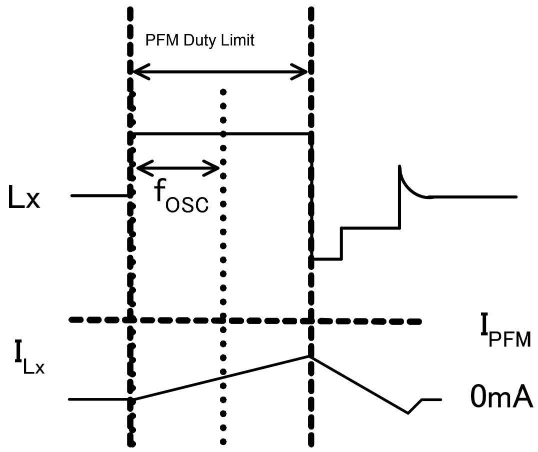
<UVLO Circuit>
When the V_{IN2} pin voltage becomes 1.4V or lower, the P-channel output driver transistor is forced OFF to prevent false pulse output caused by unstable operation of the internal circuitry. When the V_{IN2} pin voltage becomes 1.8V or higher, switching operation takes place. By releasing the UVLO function, the IC performs the soft start function to initiate output startup operation. The soft start function operates even when the V_{IN} pin voltage falls momentarily below the UVLO operating voltage. The UVLO circuit does not cause a complete shutdown of the IC, but causes pulse output to be suspended; therefore, the internal circuitry remains in operation.

<PFM Switch Current>
In the PFM control operation, until coil current reaches to a specified level (I_{PFM}) , the IC keeps the P-ch MOSFET on. In this case, on-time (t_{ON}) that the P-ch MOSFET is kept on can be given by the following formula.
$t_{ON} = L \times I_{PFM} / (V_{IN2} - V_{DCOUT})$ →I_{PFM}①

<PFM duty Limit>
In the PFM control operation, the PFM duty limit (DTY_{LIMIT_PFM}) is set to 200% (TYP.). Therefore, under the condition that the duty increases (e.g. the condition that the step-down ratio is small), it's possible for P-ch MOSFET to be turned off even when coil current doesn't reach to I_{PFM}. →I_{PFM}②



I_{PFM}①



I_{PFM}②

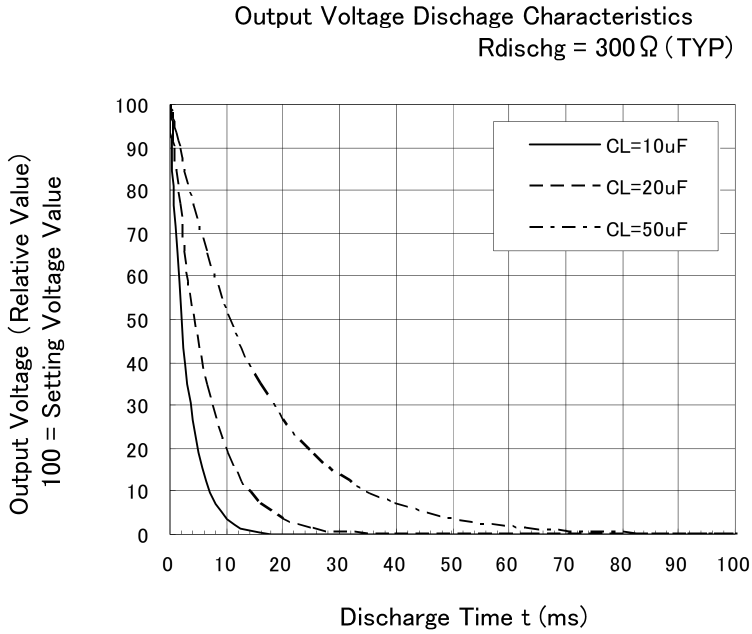
■OPERATIONAL EXPLANATION (Continued)

<C_L High Speed Discharge>

XCM524 series can quickly discharge the electric charge at the output capacitor (C_{L2}) when a low signal to the CE pin which enables a whole IC circuit put into OFF state, is inputted via the N-channel MOS switch located between the L_X pin and the V_{SS} pin. When the IC is disabled, electric charge at the output capacitor (C_L) is quickly discharged so that it may avoid application malfunction. Discharge time of the output capacitor (C_L) is set by the C_L auto-discharge resistance (R) and the output capacitor (C_L). By setting time constant of a C_L auto-discharge resistance value [R] and an output capacitor value (C_{L2}) as τ (τ =C x R), discharge time of the output voltage after discharge via the N channel transistor is calculated by the following formula.

$V = V_{DCOUT(T)} \times e^{-t/\tau}$ or $t = \tau Ln (V_{DCOUT(T)}/V)$

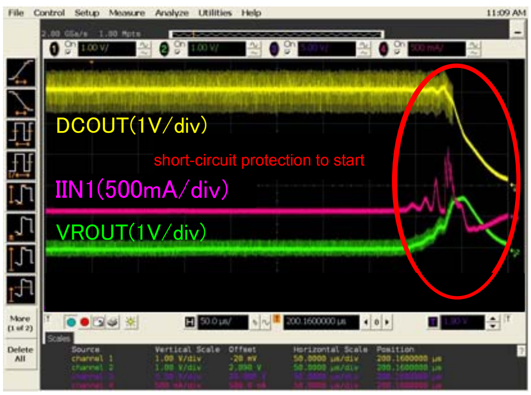
V : Output voltage after discharge,
$V_{DCOUT(T)}$: Output voltage after discharge
t: Discharge time
τ : C×R
C = Capacitance of Output capacitor （C_{L2}）
R = C_L auto-discharge resistance



■NOTE ON USE

When the DC/DC converter and the VR are connected as $V_{DCOUT}=V_{IN1}$, the following points should be noted.

1. When larger value is used in DC/DC output capacitor C_{L2}, the larger value is also used in C_{L1} as in proportional. Please be noted that when C_{L2} capacitance of the VR is getting large, an inrush current increases at VR start-up, DC/DC short circuit protection starts to operate, as a result, the IC may happen to stop.



50us/div

* VR inrush current I_{IN1} makes DC/DC short-circuit protection to start, as a result, the IC may happen to stop.

The left waver forms are taken at C_{L1}=10μ, C_{L2}=10μF(in contrast to the recommended 1.0μF).

■NOTE ON USE (Continued)

<VDR BLOCK>

1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Especially, V_{IN1} and V_{SS} wiring should be taken into consideration for reinforcement.
3. Please wire the input capacitor (C_{IN1}) and the output capacitor (C_{L1}) as close to the IC as possible. Care shall be taken for capacitor selection to ensure stability of phase compensation from the point of ESR influence.

<DC/DC BLOCK>

1. The XCM524 series is designed for use with ceramic output capacitors. If, however, the potential difference is too large between the input voltage and the output voltage, a ceramic capacitor may fail to absorb the resulting high switching energy and oscillation could occur on the output. If the input-output potential difference is large, connect an electrolytic capacitor in parallel to compensate for insufficient capacitance.
2. Spike noise and ripple voltage arise in a switching regulator as with a DC/DC converter. These are greatly influenced by external component selection, such as the coil inductance, capacitance values, and board layout of external components. Once the design has been completed, verification with actual components should be done.
3. As a result of input-output voltage and load conditions, oscillation frequency goes to 1/2, 1/3, and continues, then a ripple may increase.
4. When input-output voltage differential is large and light load conditions, a small duty cycle comes out. After that, 0%duty cycle may continue in several periods.
5. When input-output voltage differential is small and heavy load conditions, a large duty cycle comes out and may continues100% duty cycle in several periods.
6. With the IC, the peak current of the coil is controlled by the current limit circuit. Since the peak current increases when dropout voltage or load current is high, current limit starts operation, and this can lead to instability. When peak current becomes high, please adjust the coil inductance value and fully check the circuit operation. In addition, please calculate the peak current according to the following formula:

   $$Ipk = (V_{IN2} - V_{DCOUT}) \times OnDuty / (2 \times L \times f_{OSC}) + I_{OUT2}$$

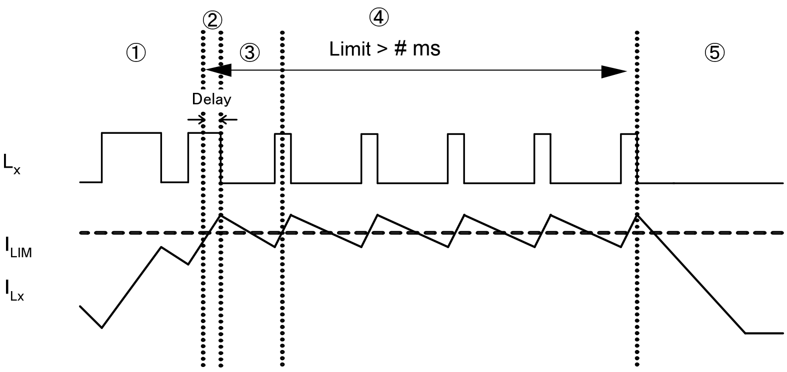
   L : Coil Inductance Value
   f_{OSC} : Oscillation Frequency

7. When the peak current which exceeds limit current flows within the specified time, the built-in P-channel MOS driver transistor turns off. During the time until it detects limit current and before the P-channel built-in transistor can be turned off, the current for limit current flows; therefore, care must be taken when selecting the rating for the external components such as a coil.
8. Depending on the state of the PC Board, latch time may become longer and latch operation may not work. In order to avoid the effect of noise, the board should be laid out so that input capacitors are placed as close to the IC as possible.
9. Use of the IC at voltages below the recommended voltage range may lead to instability.
10. This IC should be used within the stated absolute maximum ratings in order to prevent damage to the device.
11. When the IC is used in high temperature, output voltage may increase up to input voltage level at no load because of the leak current of the P-channel MOS driver transistor.

■NOTE ON USE (Continued)

12. The current limit is set to 1350mA (MAX.) at typical. However, the current of 1350mA or more may flow.
In case that the current limit functions while the DCOUT pin is shorted to the GND pin, when P-channel MOSFET is ON, the potential difference for input voltage will occur at both ends of a coil. For this, the time rate of coil current becomes large. By contrast, when N- channel MOSFET switch is ON, there is almost no potential difference at both ends of the coil since the DCOUT pin is shorted to the GND pin. Consequently, the time rate of coil current becomes quite small. According to the repetition of this operation, and the delay time of the circuit, coil current will be converged on a certain current value, exceeding the amount of current, which is supposed to be limited originally. Even in this case, however, after the over current state continues for several ms, the circuit will be latched. A coil should be used within the stated absolute maximum rating in order to prevent damage to the device.

①Current flows into P-channel MOS driver transistor to reach the current limit (I_{LIM}).
②The current of I_{LIM} or more flows since the delay time of the circuit occurs during from the detection of the current limit to OFF of P-channel MOS driver transistor.
③Because of no potential difference at both ends of the coil, the time rate of coil current becomes quite small.
④Lx oscillates very narrow pulses by the current limit for several ms.
⑤The circuit is latched, stopping its operation.

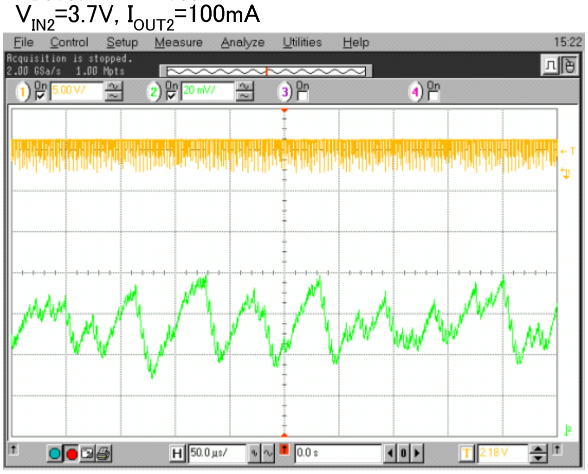


13. In order to stabilize V_{IN1}'s voltage level and oscillation frequency, we recommend that a by-pass capacitor (C_{IN2}) be connected as close as possible to the V_{IN2} & V_{SS} pins.
14. High step-down ratio and very light load may lead an intermittent oscillation.
15. During PWM / PFM automatic switching mode, operating may become unstable at transition to continuous mode.
Please verify with actual parts.

V_{DCOUT}=3.3V, f_{OSC}=1.2MHz
V_{IN2}=3.7V, I_{OUT2}=100mA

CH1:Lx 5V/div

CH2:VDCOUT 20mV/div



<External Components>
L:4.7 μ H(NR4018)
CIN2:4.7 μ F(Ceramic)
CL2:10 μ F(Ceramic)

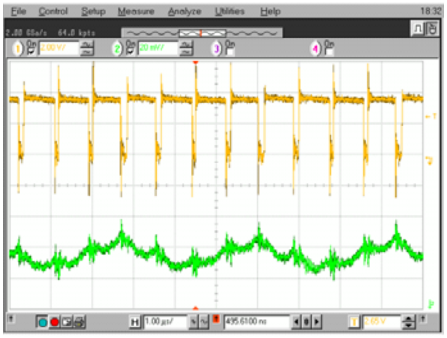
■NOTE ON USE (Continued)

16. Please note the L value of the coil. The IC may enter unstable operation if the combination of ambient temperature, setting voltage, oscillation frequency, and L value are not adequate.

V_{DCOUT}=3.3V, f_{OSC}=1.2MHz
V_{IN2}=4.0V, I_{OUT2}=180mA

CH1:Lx 2V/div

CH2:VDCOUT 20mV/div



<External Components>
L:1.5μH(NR3015)
CIN2:4.7μF(Ceramic)
CL2:10μF(Ceramic)

●The Range of L Value

f_{OSC}	V_{DCOUT}	L Value
3.0MHz	0.8V≦V_{DCOUT}≦4.0V	1.0μH～2.2μH
1.2MHz	V_{DCOUT}≦2.5V	3.3μH～6.8μH
	2.5V＜V_{DCOUT}	4.7μH～6.8μH

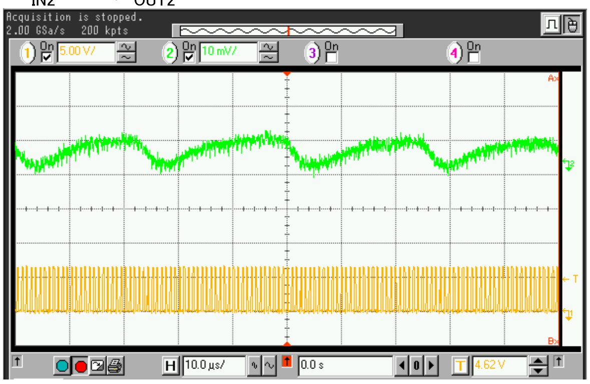
*When a coil less value of 4.7μH is used at when a coil less value of 1.5μH is used at f_{OSC}=3.0MHz, peak coil current more easily reach the current limit ILMI. In this case, it may happen that the IC can not provide 600mA output current.

17. Under input-output voltage differential is large, operating may become unstable at transition to continuous mode. Please verify with actual parts.

V_{DCOUT}=1.8V, f_{OSC}=1.2MHz
V_{IN2}=6.0V, I_{OUT2}=100mA

CH2:VDCOUT 10mV/div

CH1:Lx 5V/div

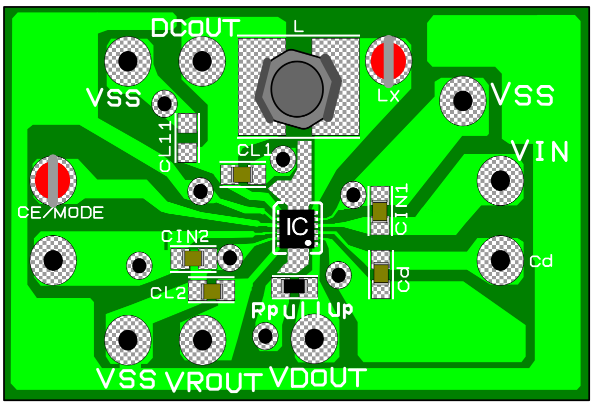


<External Components>
L:4.7μH(NR4018)
CIN2:4.7μF(Ceramic)
CL2:10μF(Ceramic)

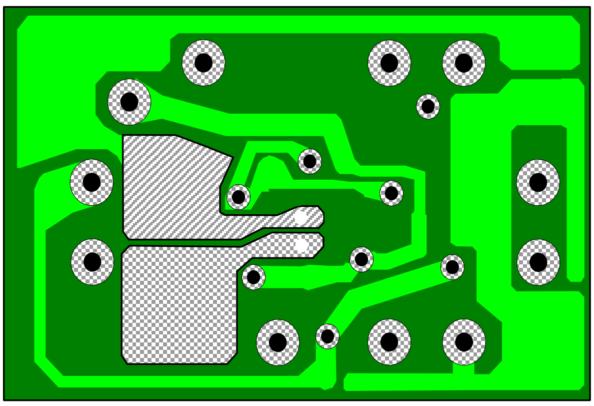
●Instructions of pattern layouts

1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. In order to stabilize V_{IN1} • V_{IN2} • DCOUT・V_{ROUT} voltage level, we recommend that a by-pass capacitor (C_{IN1} • C_{IN2} • C_{L1} • C_{L2}) be connected as close as possible to the V_{IN1} • V_{IN2} • DCOUT・V_{ROUT} and GND・V_{SS} pins.
3. Please mount each external component as close to the IC as possible.
4. Wire external components as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance.
5. V_{SS} (AGND • PGND • V_{SS}) ground wiring is recommended to get large area. The IC may goes into unstable operation as a result of V_{SS} voltage level fluctuation during the switching.
6. This series' internal driver transistors bring on heat because of the output current (I_{OUT}) and ON resistance of driver transistors.

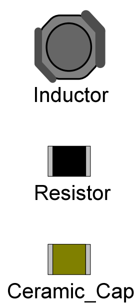
●Recommended Pattern Layout



Front

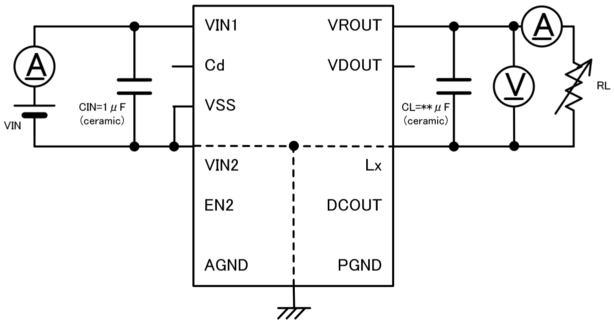


Back

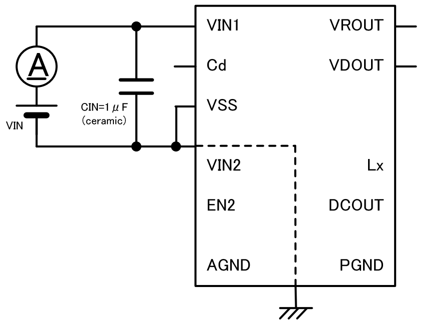


■TEST CIRCUITS

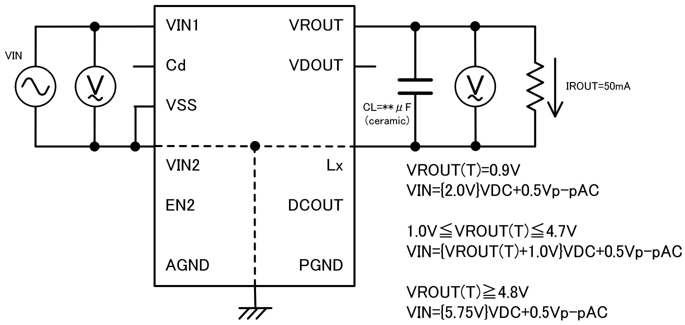
Circuit No.1



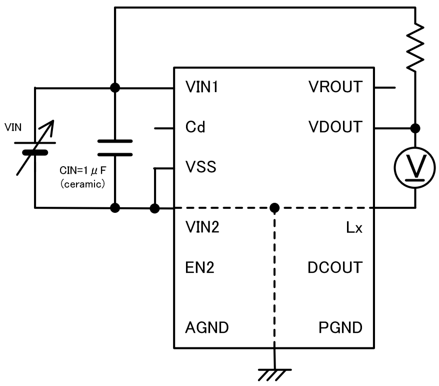
Circuit No.2



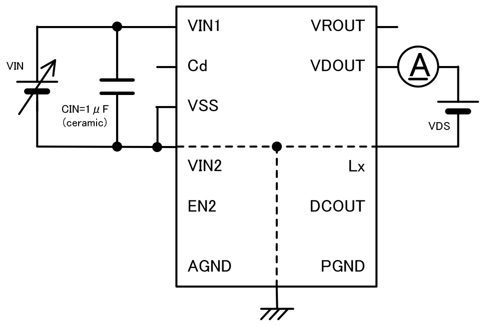
Circuit No.3



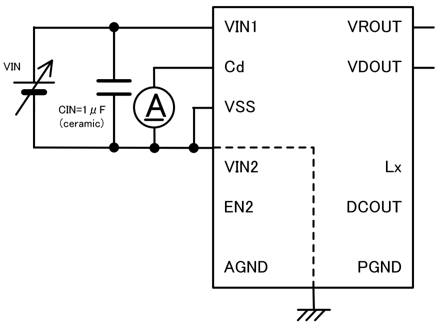
Circuit No.4



Circuit No.5



Circuit No.6

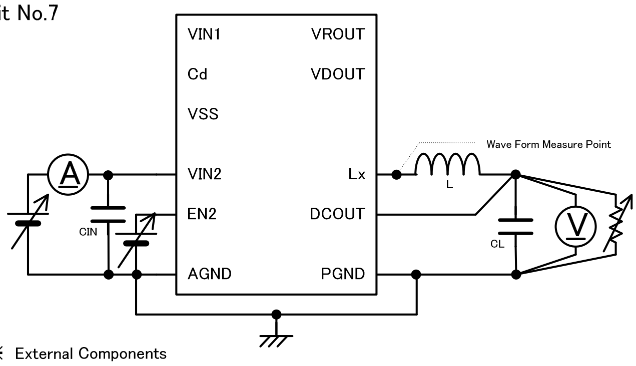


Outpur Capacitor

V_{ROUT}	0.9 ~1.2V	1.3 ~ 1.7V	1.8V ~ 5.1V
C_L	≧4.7μF	≧2.2μF	≧1.0μF

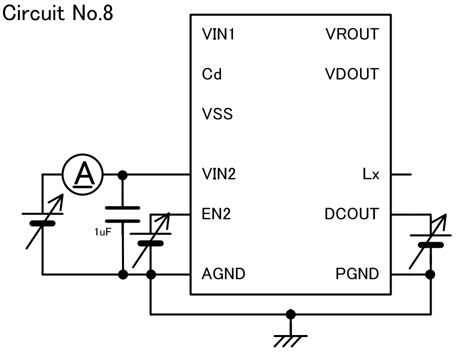
■TEST CIRCUITS (Continued)

Circuit No.7

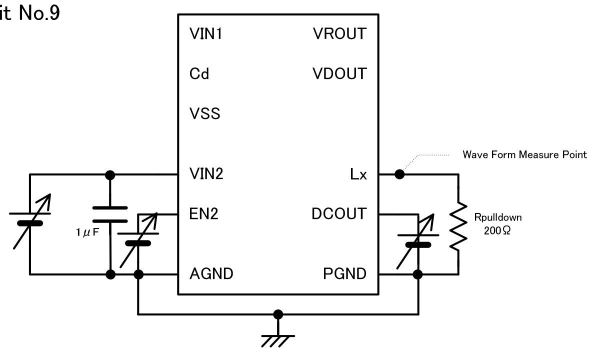


※ External Components
L : 1.5μH(NR3015) 3.0MHz, 4.7μH(NR4018) 1.2MHz
CIN : 4.7μF(ceramic), CL : 10μF(ceramic)

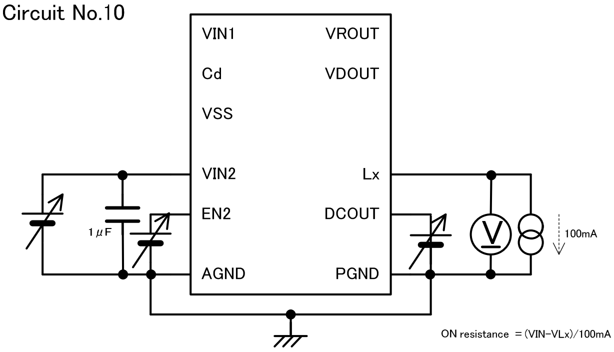
Circuit No.8



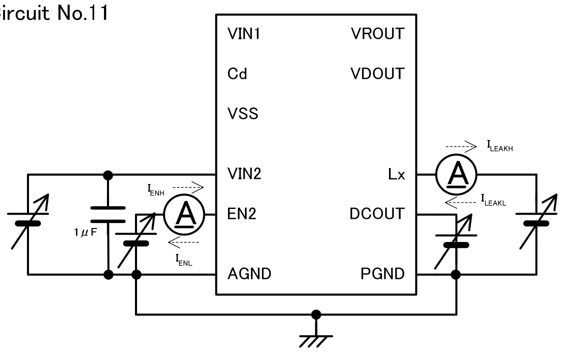
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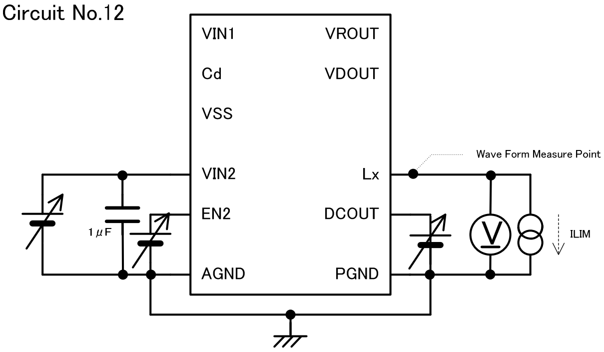
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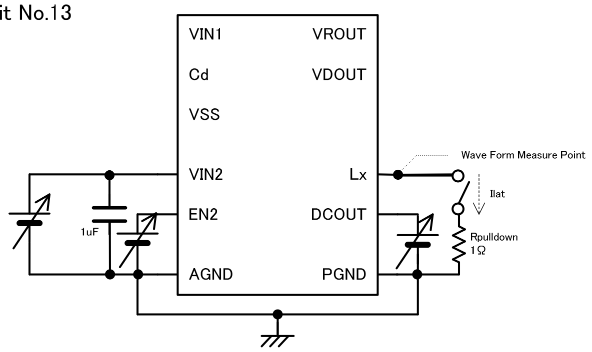
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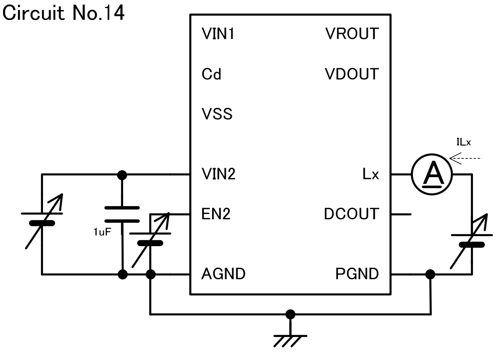
Circuit No.12



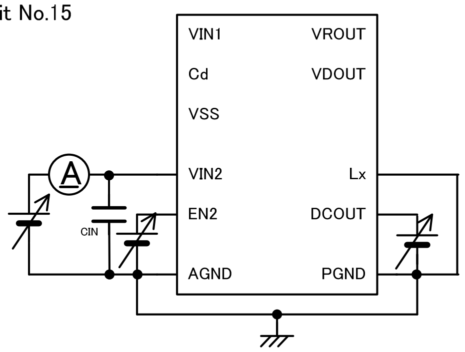
Circuit No.13



Circuit No.14



Circuit No.15

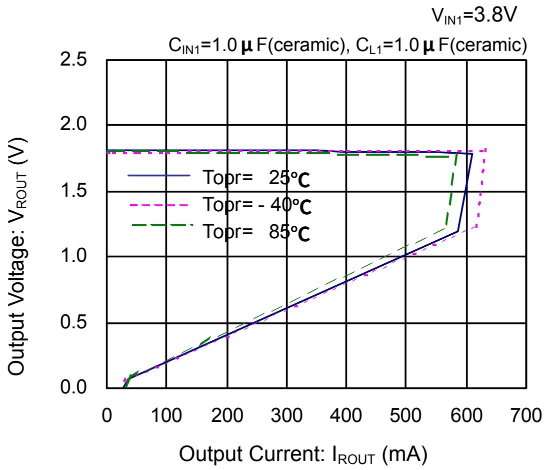


■TYPICAL PERFORMANCE CHARACTERISTICS

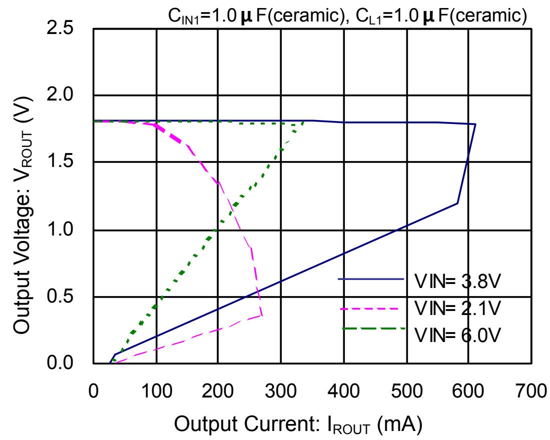
●1ch:VDR Block

(1) VR Output Voltage vs. VR Output Current

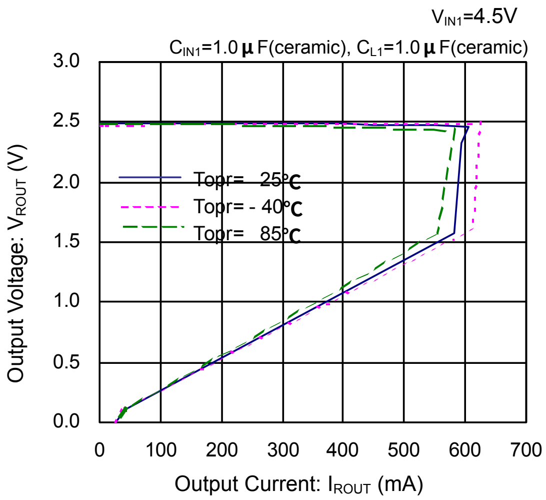
V_{ROUT}=1.8V



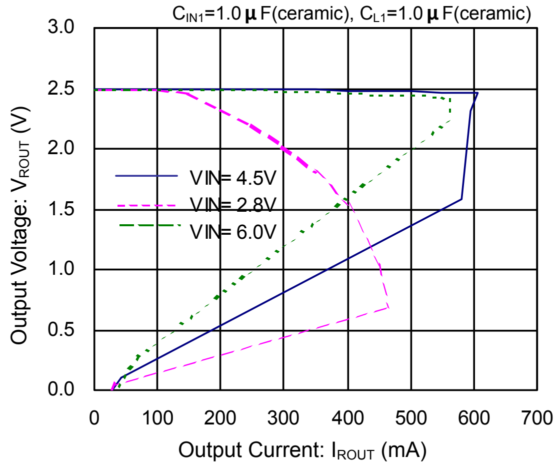
V_{ROUT}=1.8V



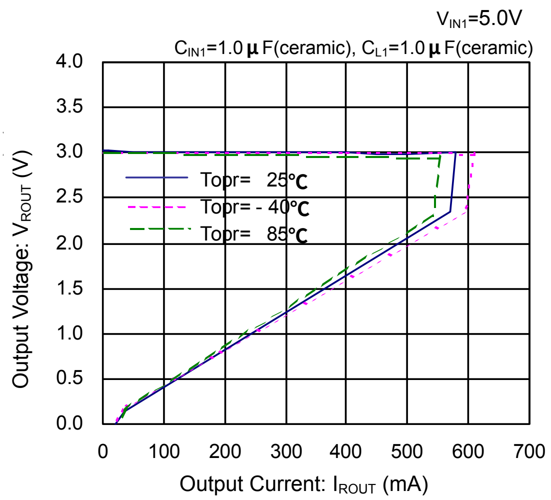
V_{ROUT}=2.5V



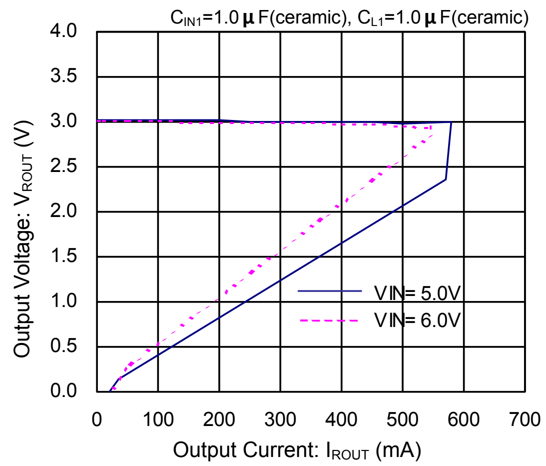
V_{ROUT}=2.5V



V_{ROUT}=3.0V

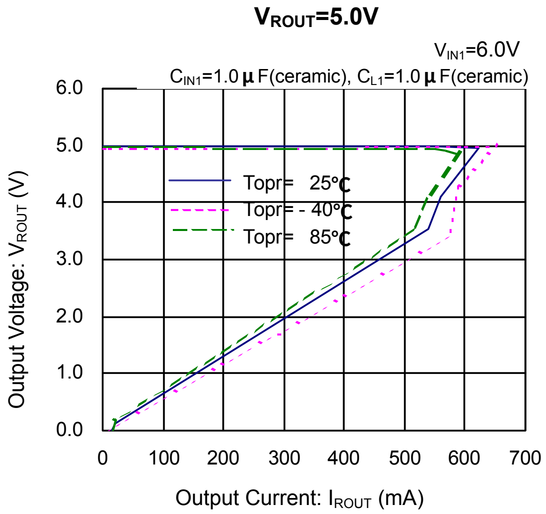


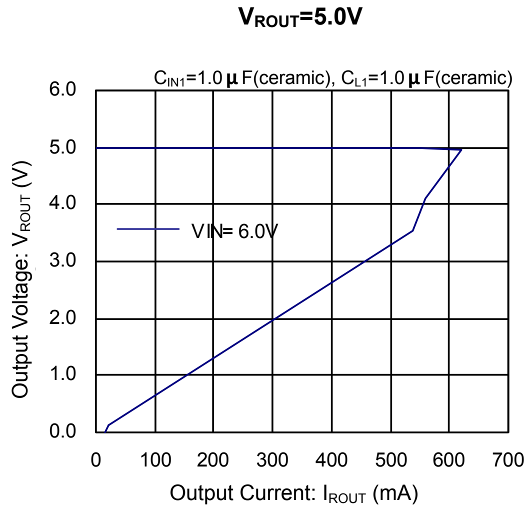
V_{ROUT}=3.0V

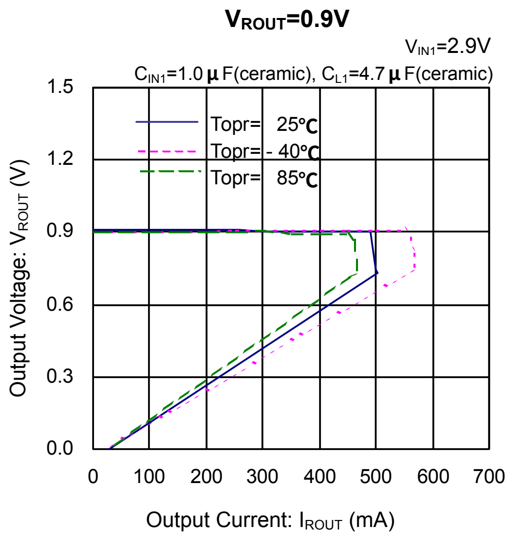


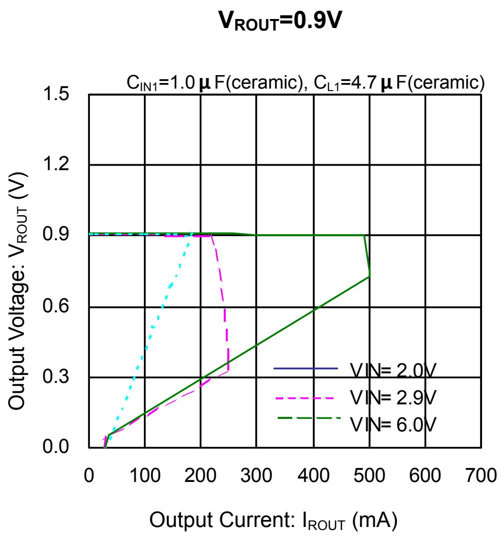
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(1) VR Output Voltage vs. VR Output Current (Continued)



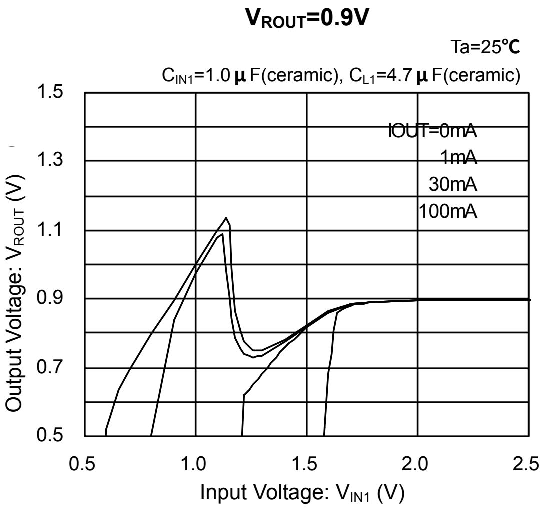


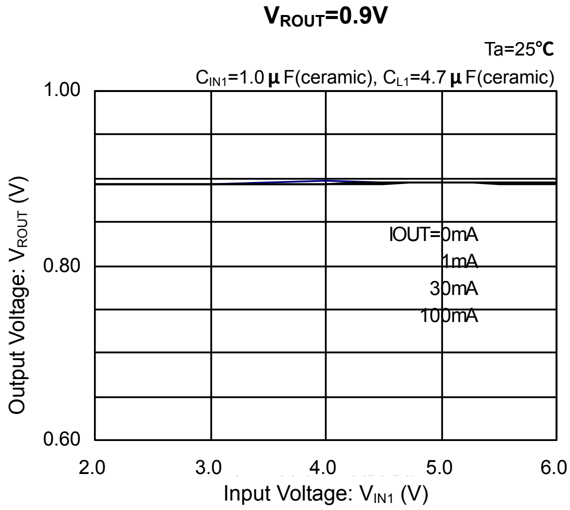


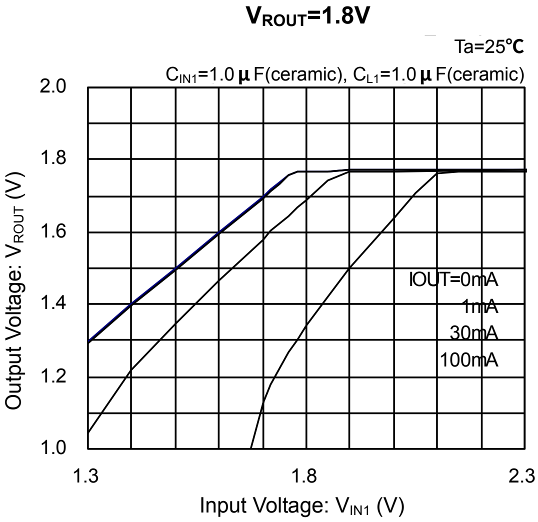


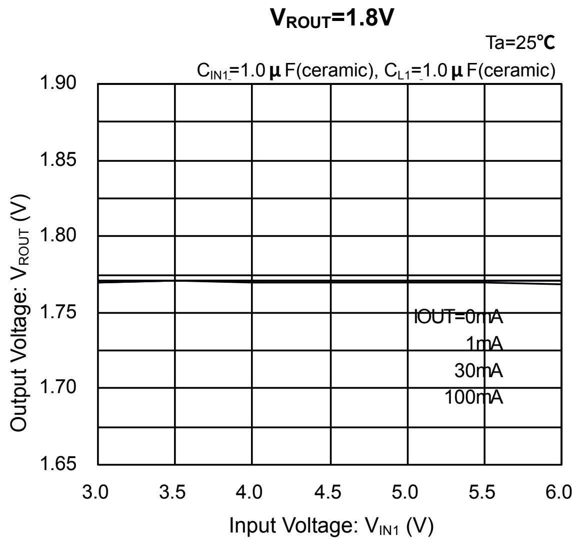
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

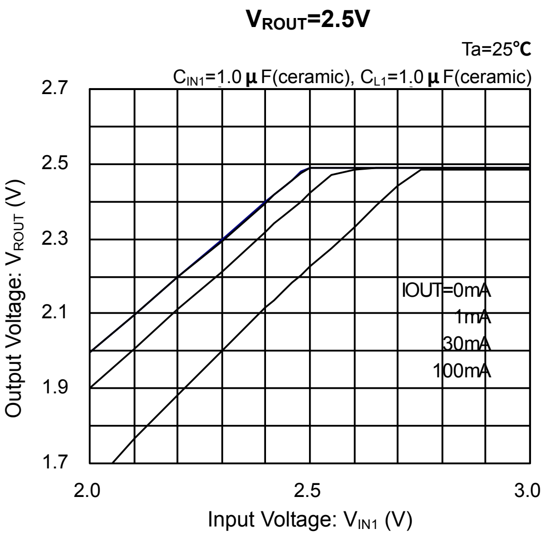
(2) VR Output Voltage vs. Input Voltage

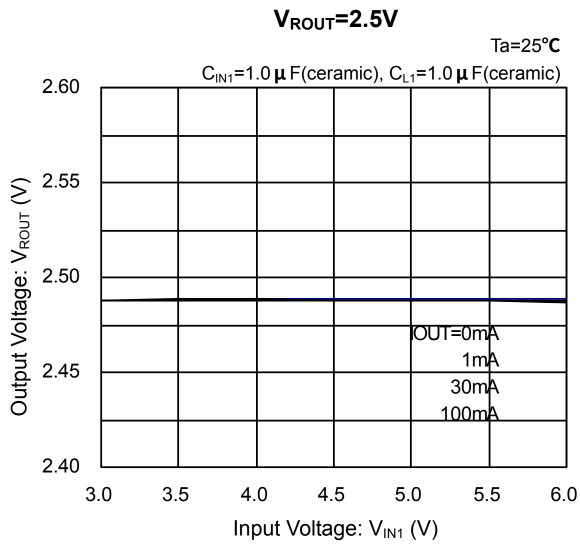






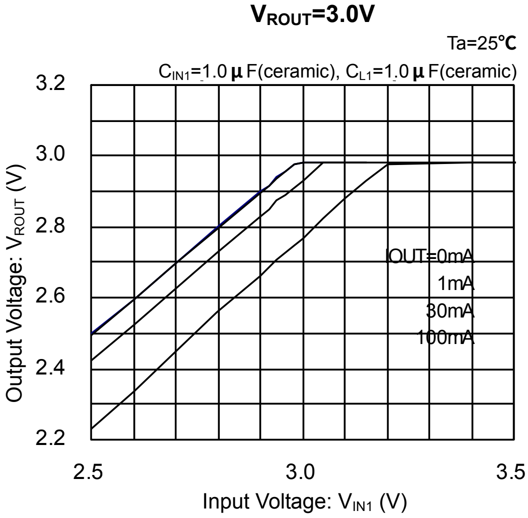


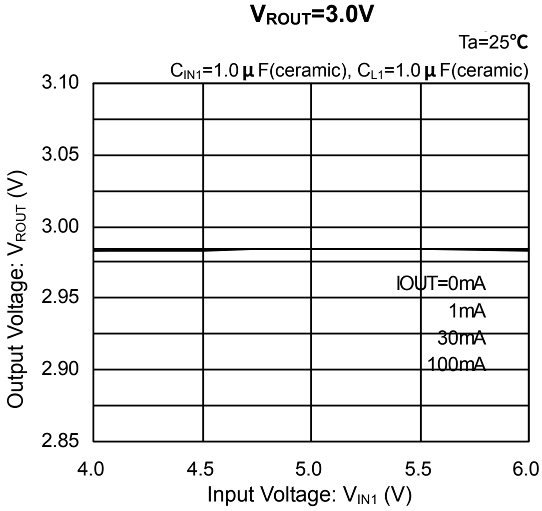


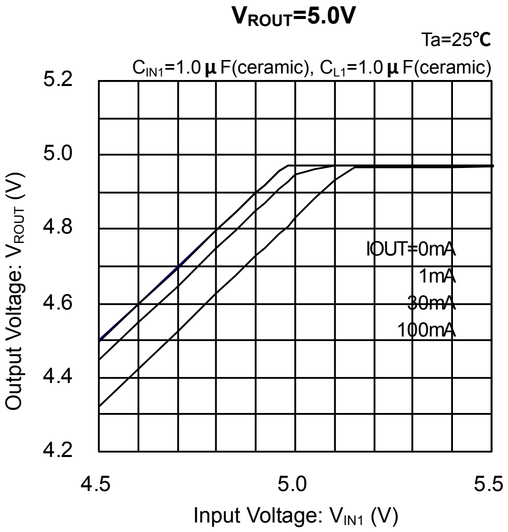


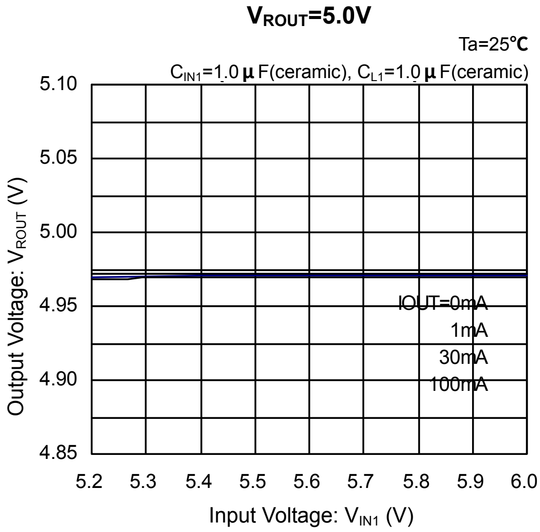
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) VR Output Voltage vs. Input Voltage (Continued)



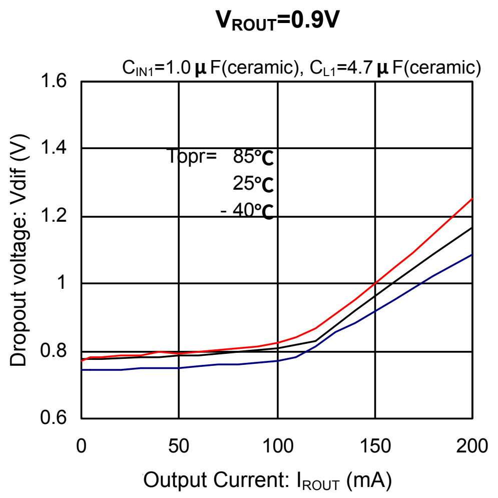


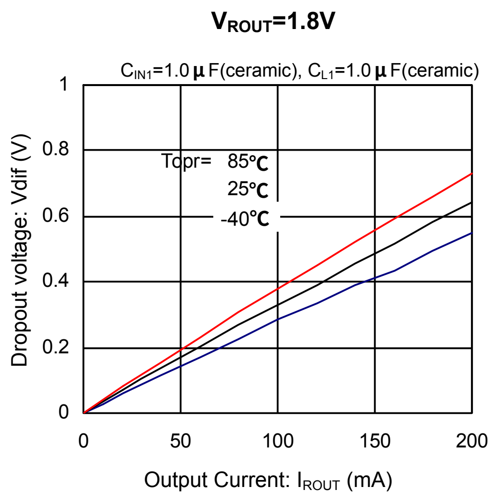


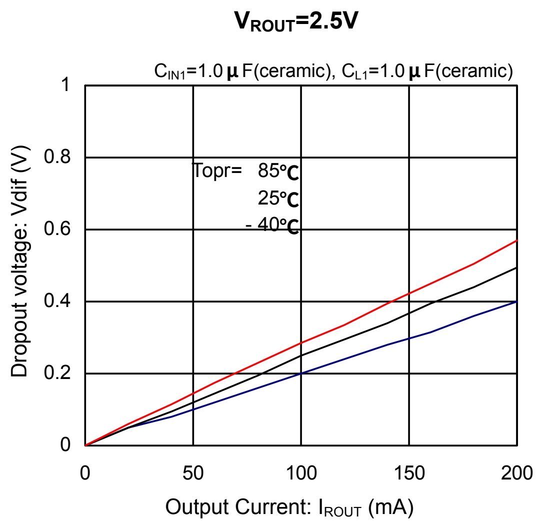


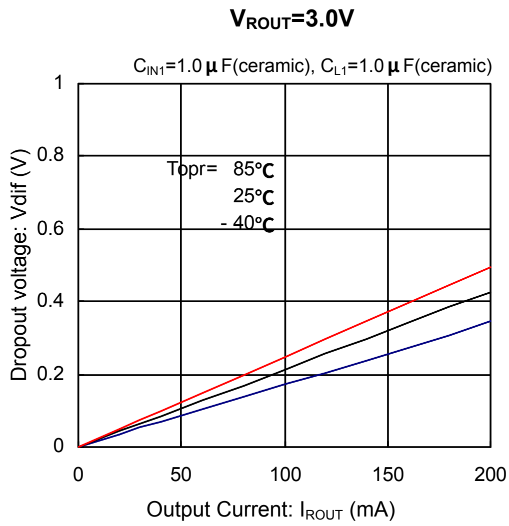
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

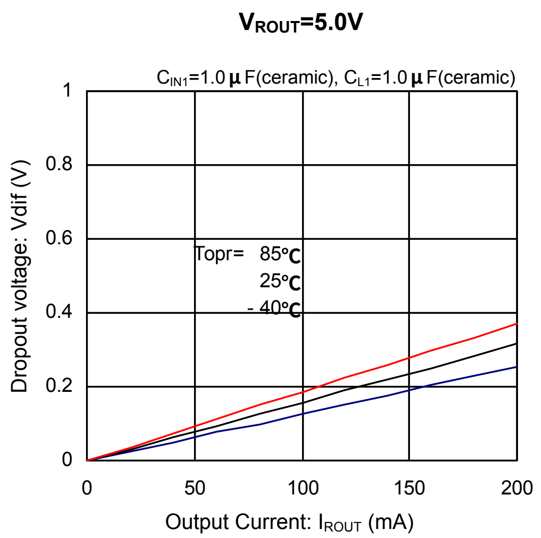
(3) Dropout Voltage vs. VR Output Current







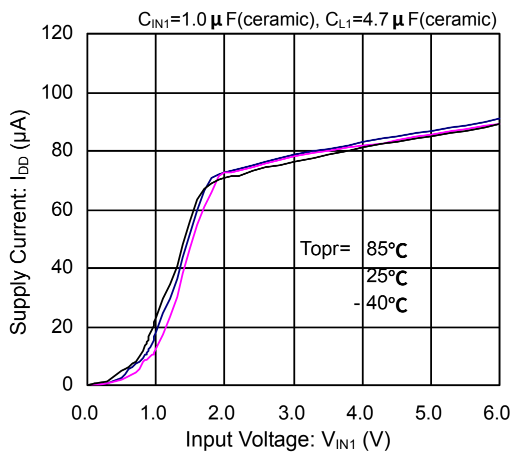




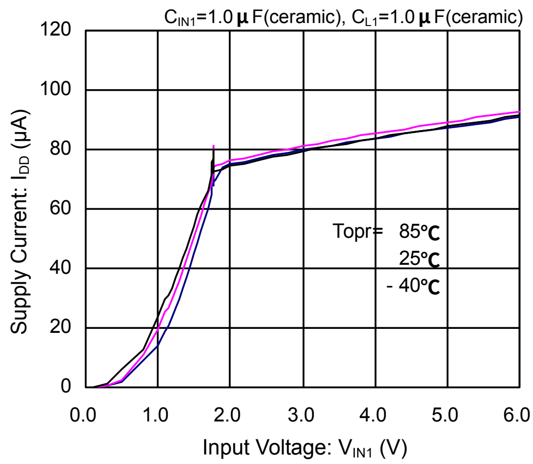
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(4) Supply Current vs. Input Voltage

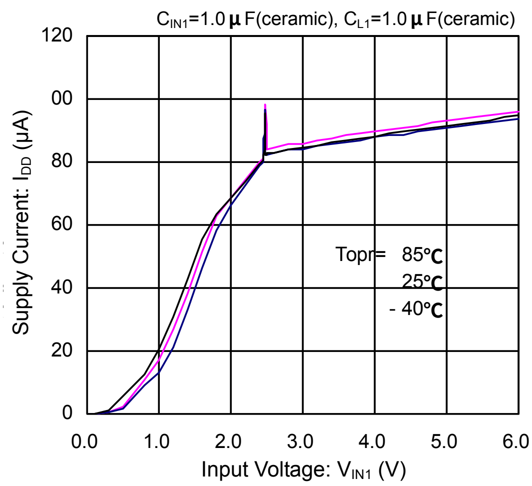
V_{ROUT}=0.9V



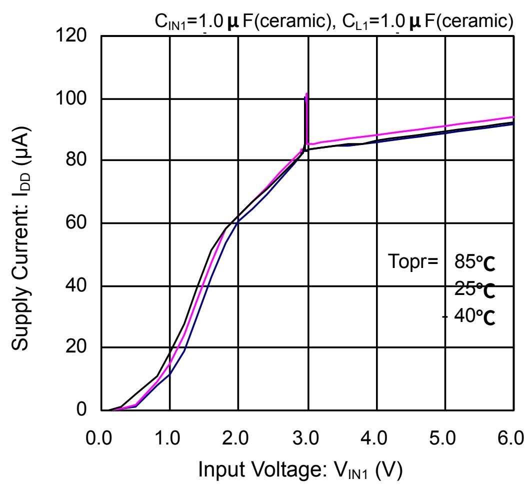
V_{ROUT}=1.8V



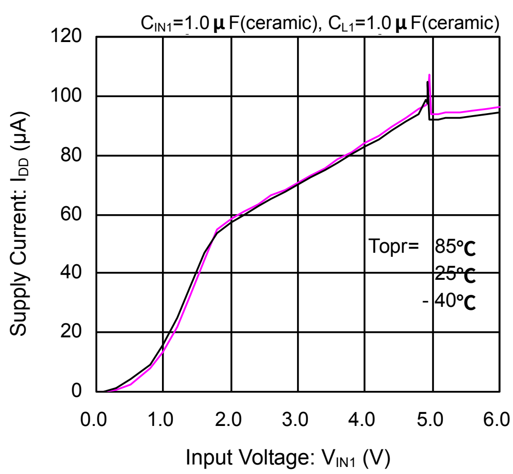
V_{ROUT}=2.5V



V_{ROUT}=3.0V

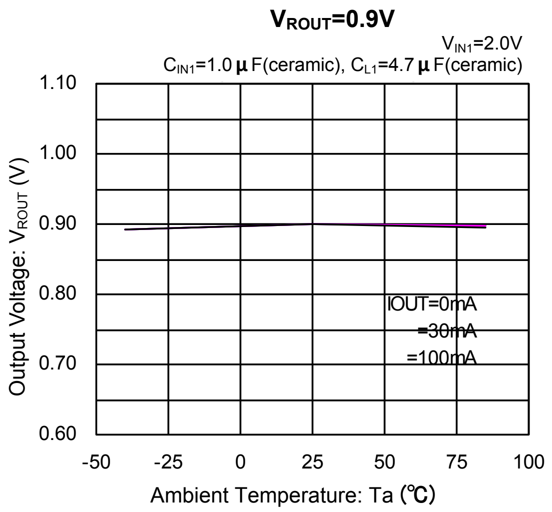


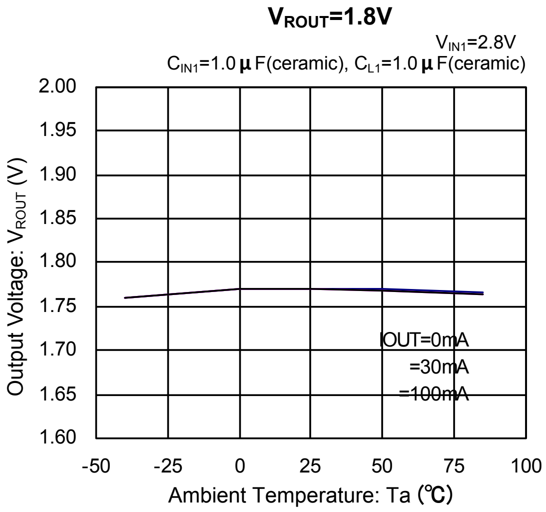
V_{ROUT}=5.0V

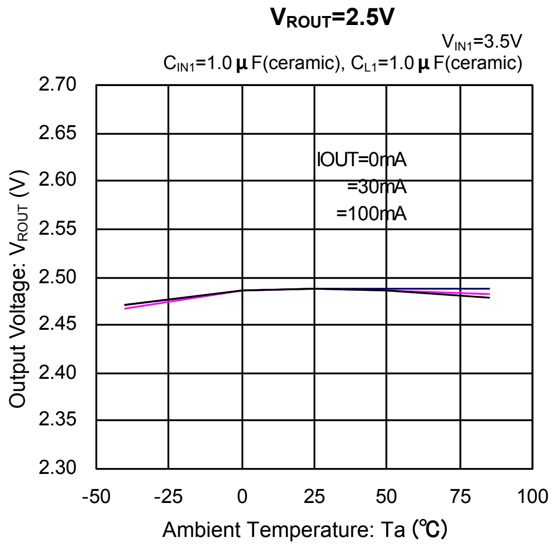


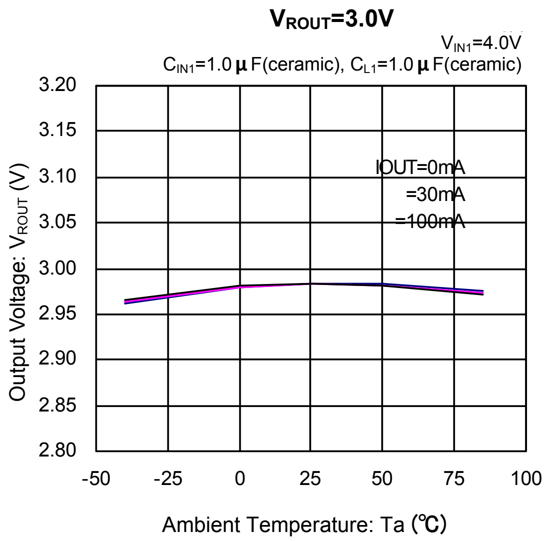
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

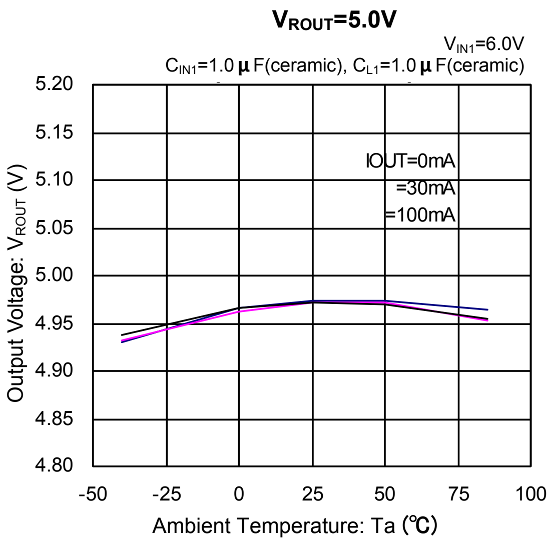
(5) VR Output Voltage vs. Ambient Temperature





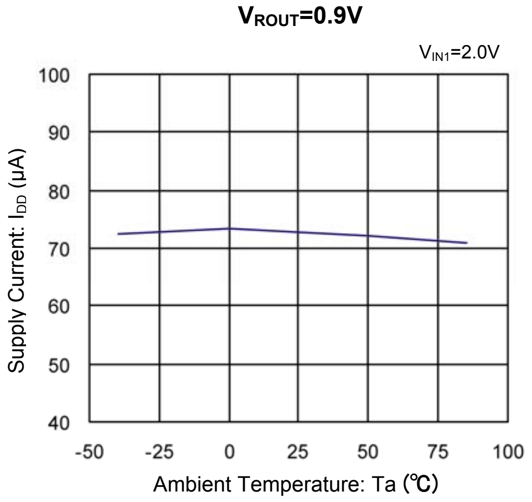


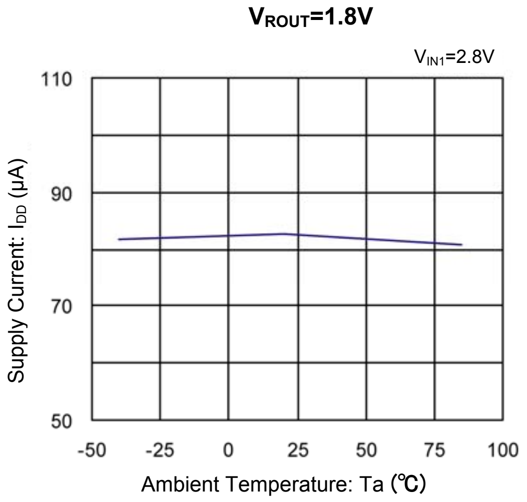


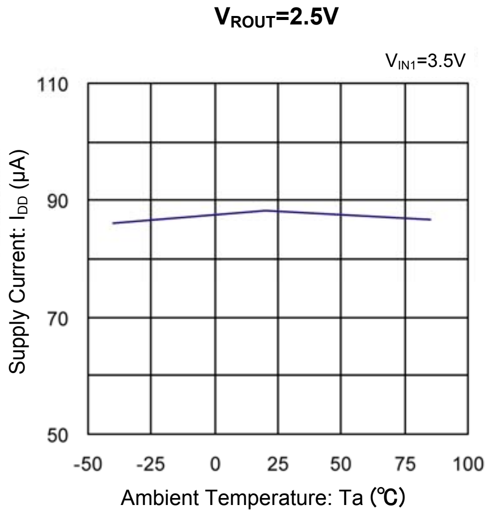


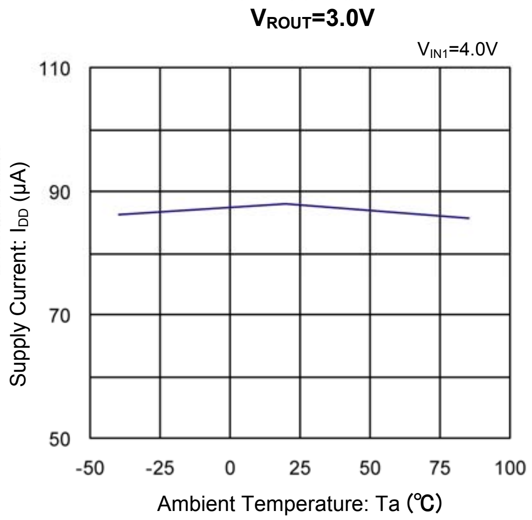
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

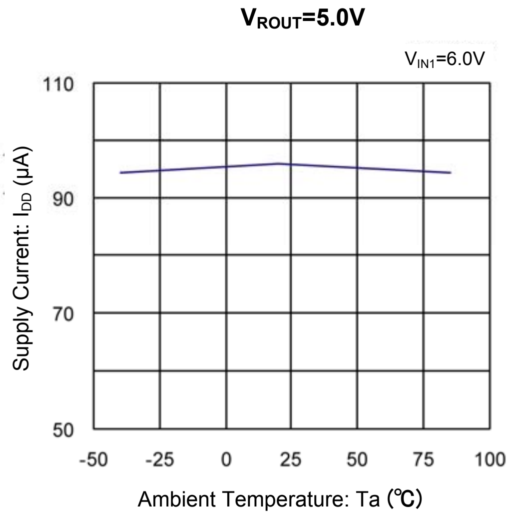
(6) Supply Current vs. Ambient Temperature





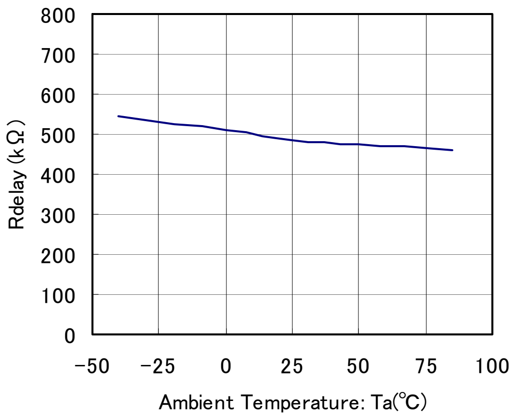




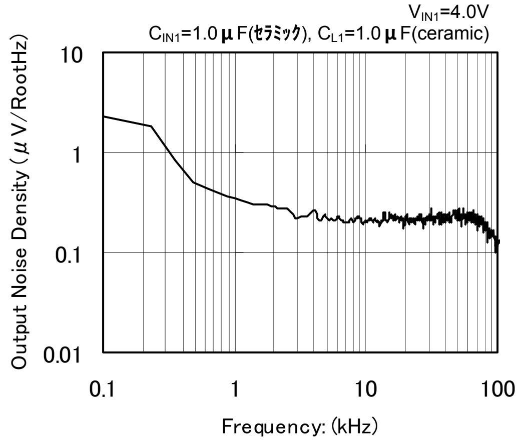


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Rdelay vs. Ambient Temperature

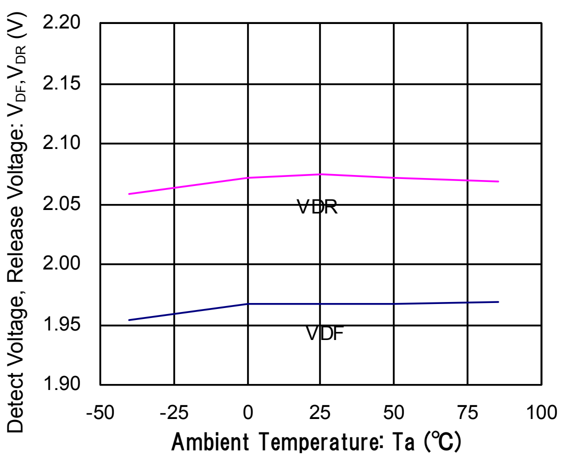


(8) Output Noise Density

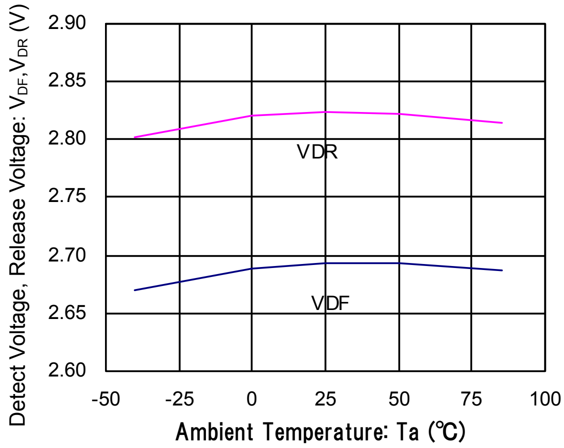


(9) Detect Voltage, Release Voltage vs. Ambient Temperature

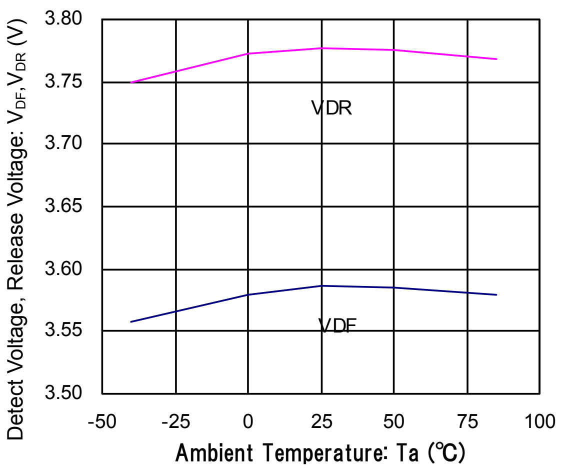
V_{DF}=2.0V



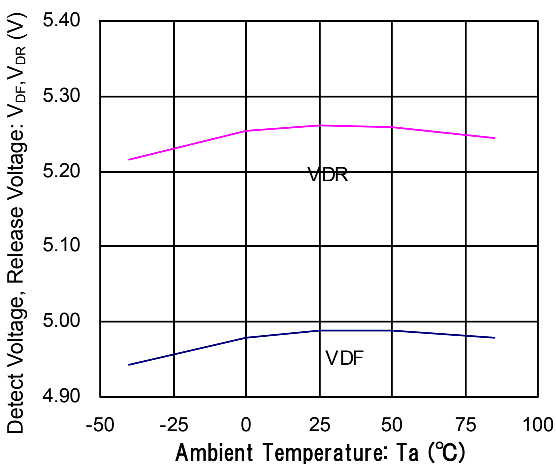
V_{DF}=2.7V



V_{DF}=3.6V

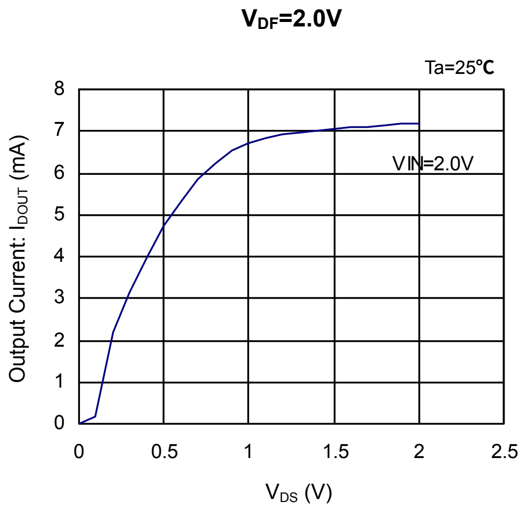


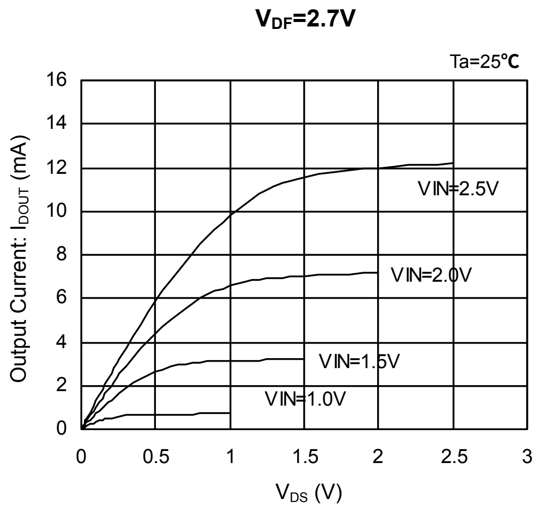
V_{DF}=5.0V

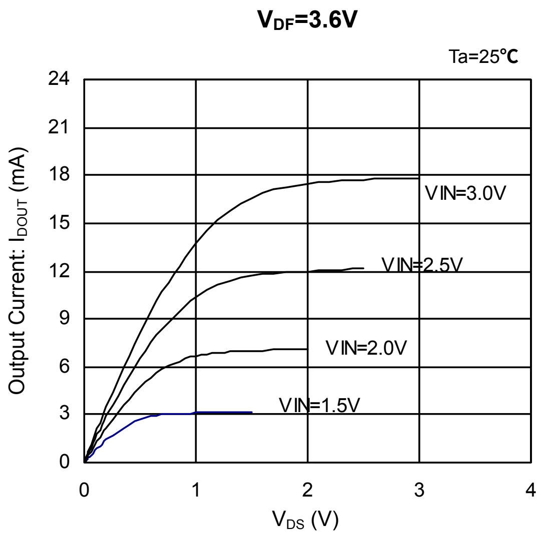


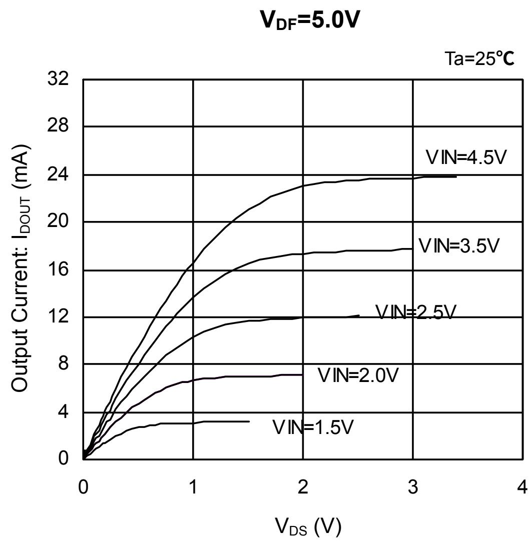
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) VD N-channel Driver Transistor Output Current vs. VDS



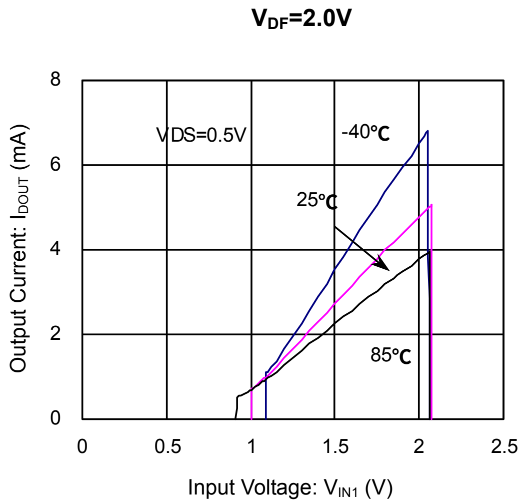


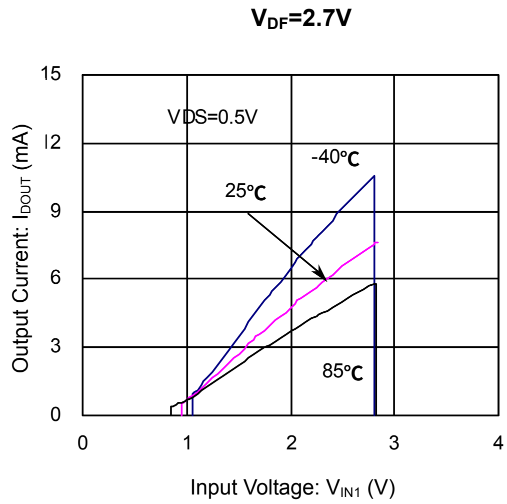


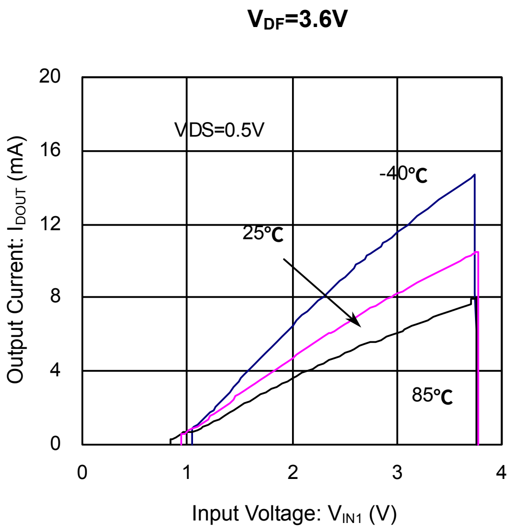


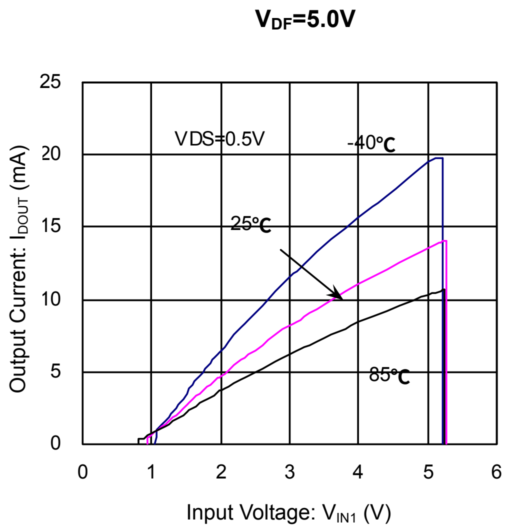
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(11) VD N-channel Driver Transistor Output Current vs. Input Voltage



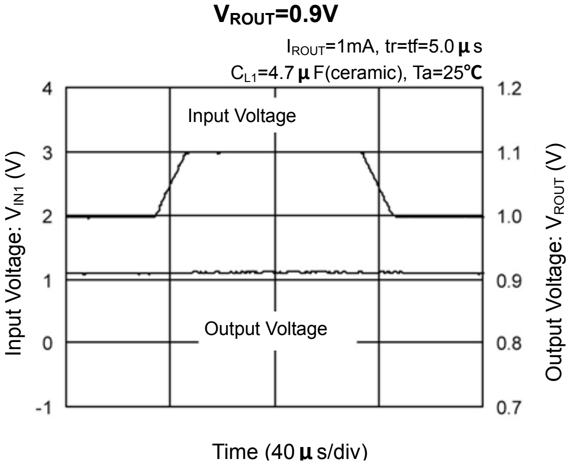


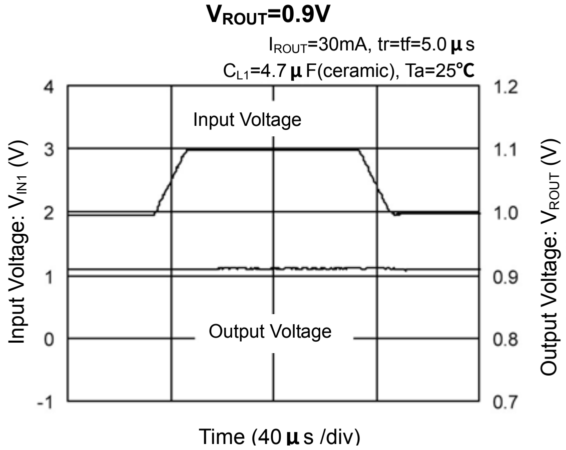


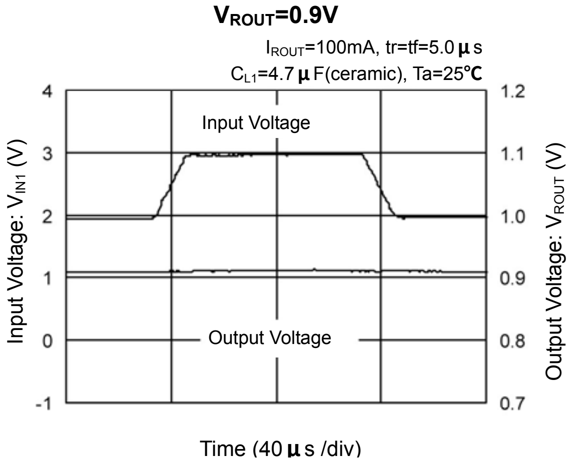


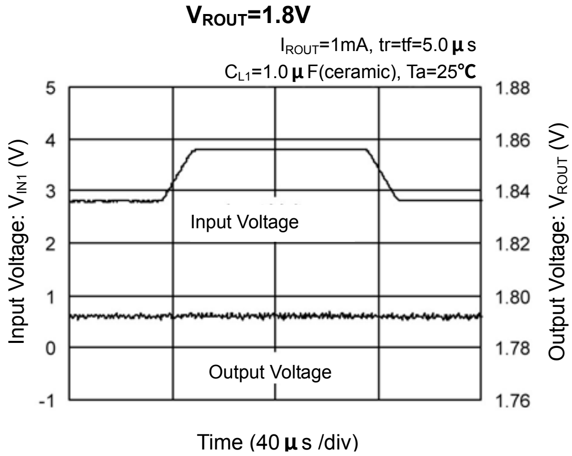
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

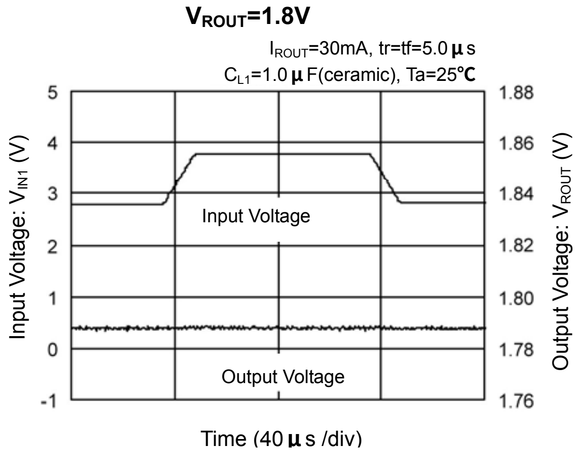
(12) Input Transient Response

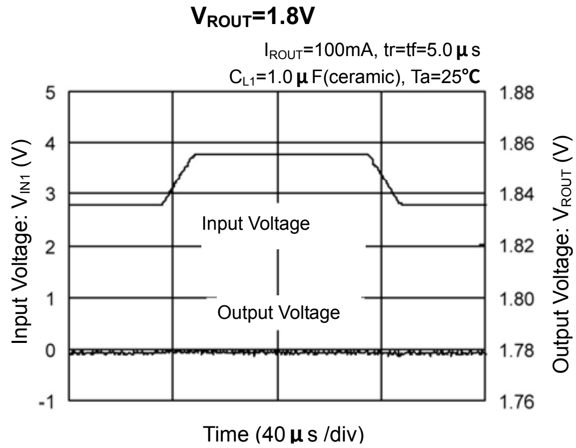










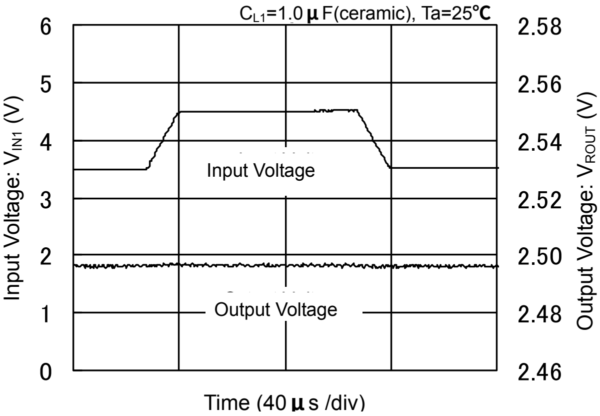


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Input Transient Response (Continued)

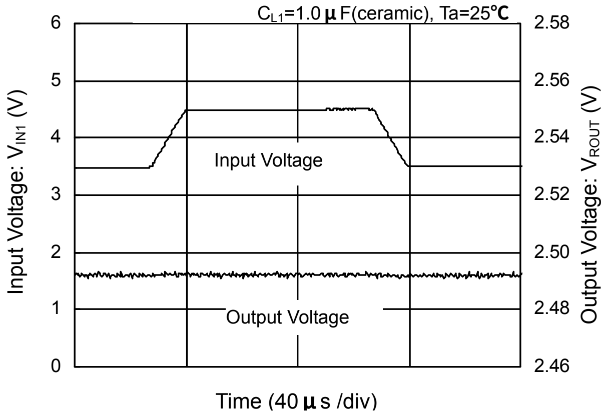
V_{ROUT}=2.5V

I_{ROUT}=1mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃



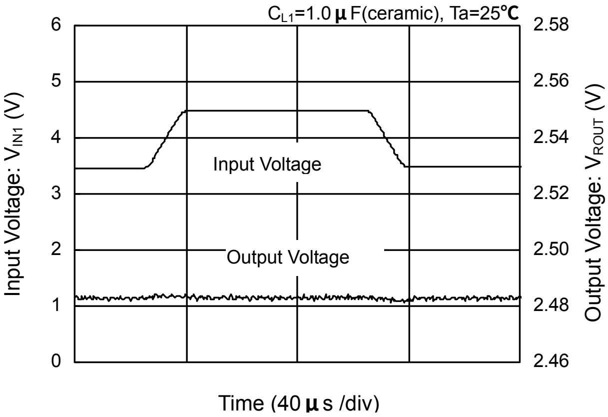
V_{ROUT}=2.5V

I_{ROUT}=30mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃



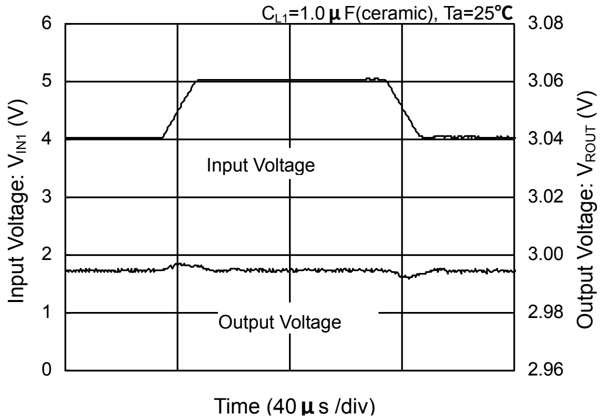
V_{ROUT}=2.5V

I_{ROUT}=100mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃



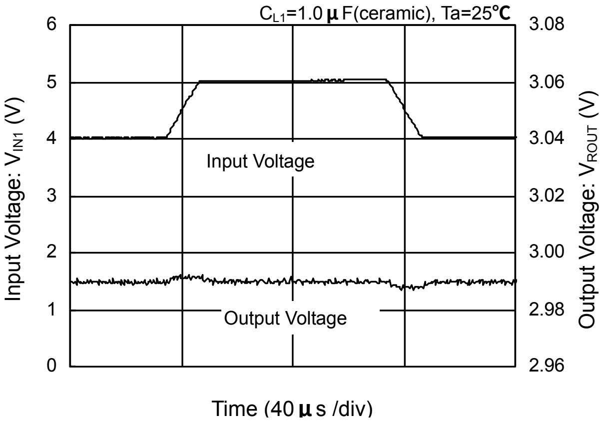
V_{ROUT}=3.0V

I_{ROUT}=1mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃



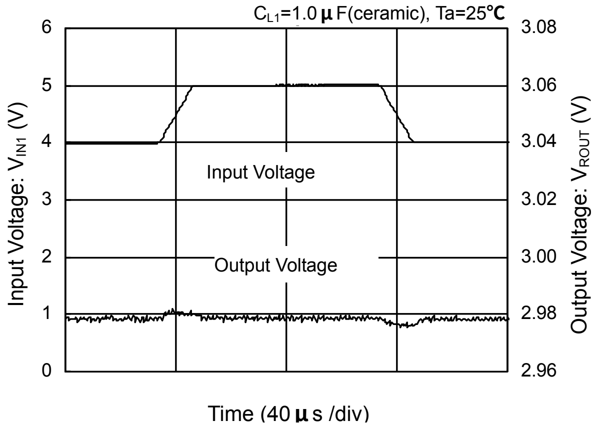
V_{ROUT}=3.0V

I_{ROUT}=30mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃



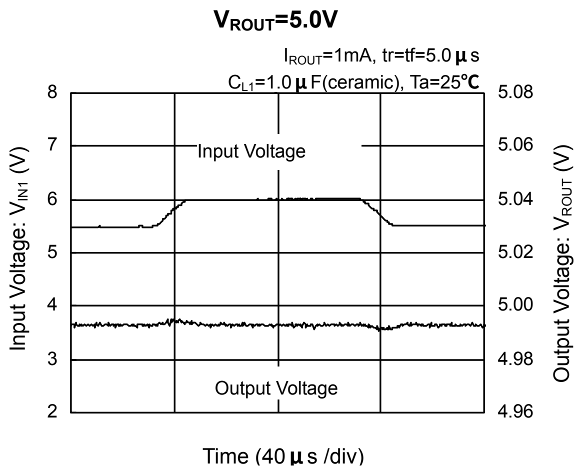
V_{ROUT}=3.0V

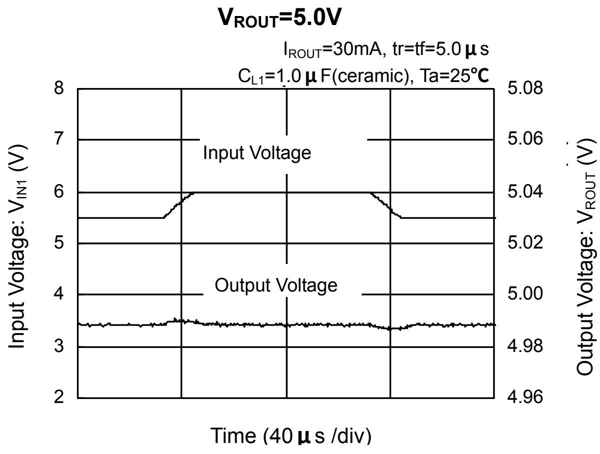
I_{ROUT}=100mA, tr=tf=5.0µs
C_{L1}=1.0µF(ceramic), Ta=25℃

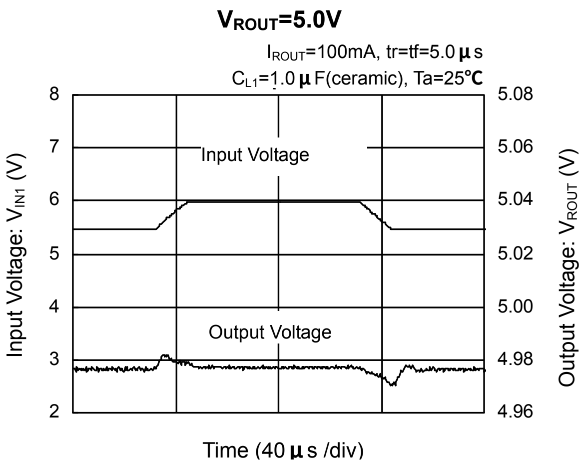


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) Input Transient Response (Continued)





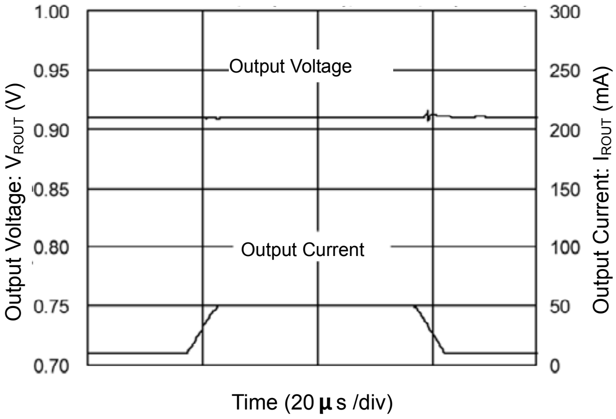


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(13) Load Transient Response

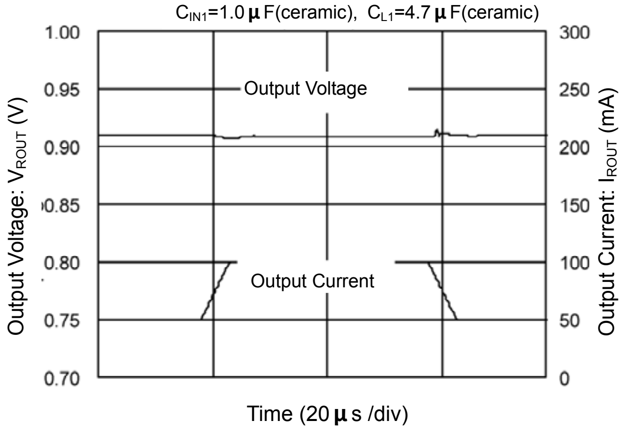
V_{ROUT}=0.9V

V_{IN1}=2.0V, tr=tf=5.0μs, Ta=25℃
C_{IN1}=1.0μF(ceramic), C_{L1}=4.7μF(ceramic)



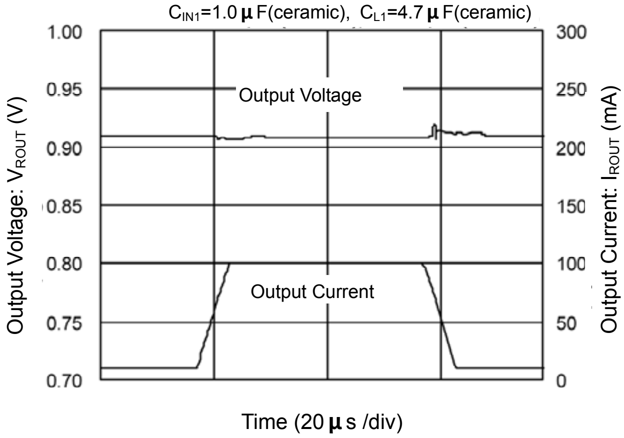
V_{ROUT}=0.9V

V_{IN1}=2.0V, tr=tf=5.0μs, Ta=25℃
C_{IN1}=1.0μF(ceramic), C_{L1}=4.7μF(ceramic)



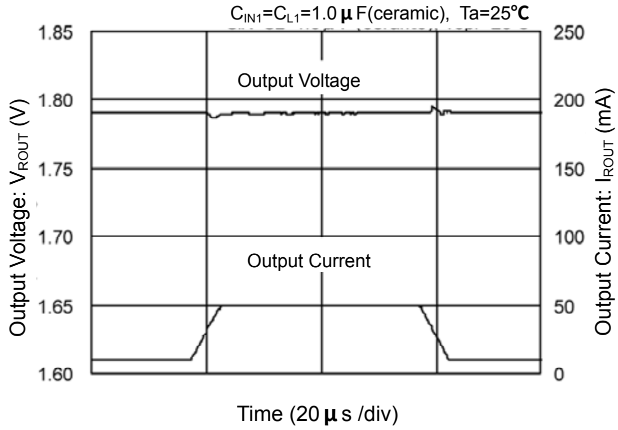
V_{ROUT}=0.9V

V_{IN1}=2.0V, tr=tf=5.0μsec, Ta=25℃
C_{IN1}=1.0μF(ceramic), C_{L1}=4.7μF(ceramic)



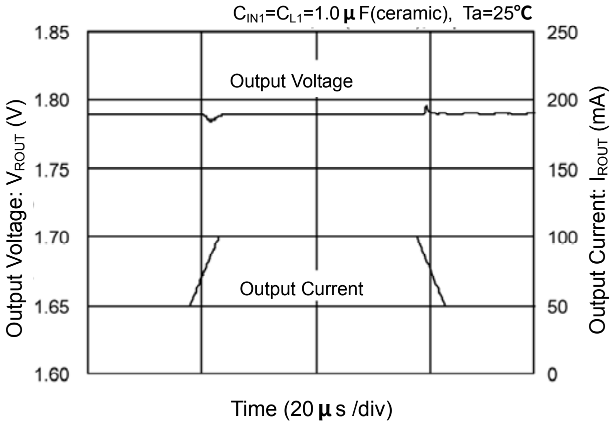
V_{ROUT}=1.8V

V_{IN1}=2.8V, tr=tf=5.0μs
C_{IN1}=C_{L1}=1.0μF(ceramic), Ta=25℃



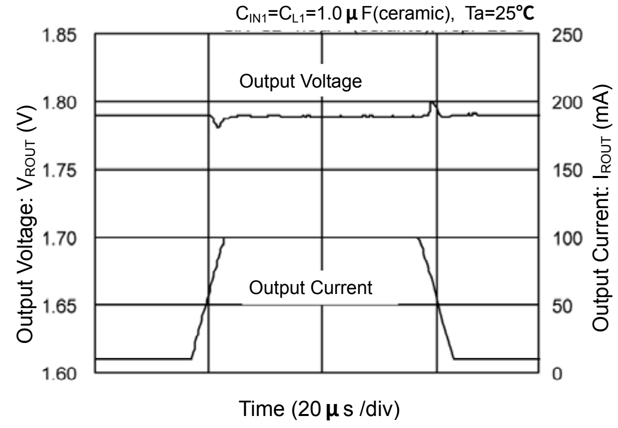
V_{ROUT}=1.8V

V_{IN1}=2.8V, tr=tf=5.0μs
C_{IN1}=C_{L1}=1.0μF(ceramic), Ta=25℃



V_{ROUT}=1.8V

V_{IN1}=2.8V, tr=tf=5.0μs
C_{IN1}=C_{L1}=1.0μF(ceramic), Ta=25℃

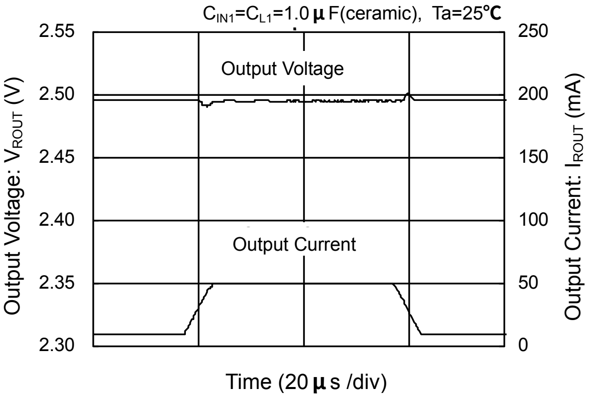


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(13) Load Transient Response (Continued)

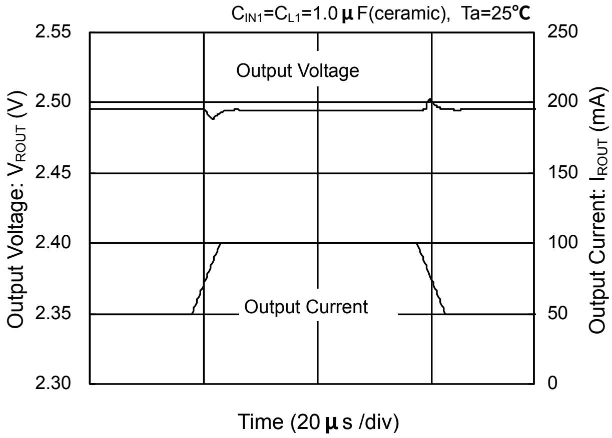
V_{ROUT}=2.5V

V_{IN1}=3.5V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃



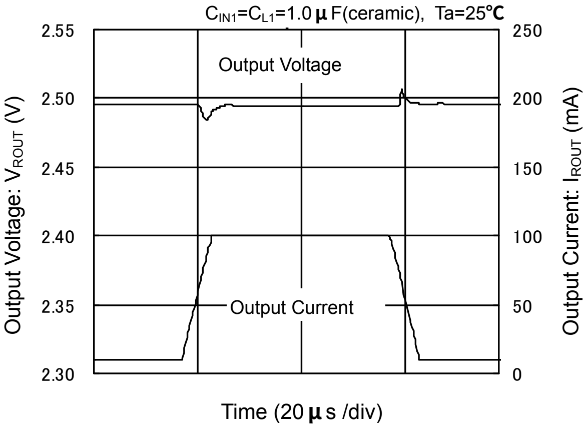
V_{ROUT}=2.5V

V_{IN1}=3.5V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃



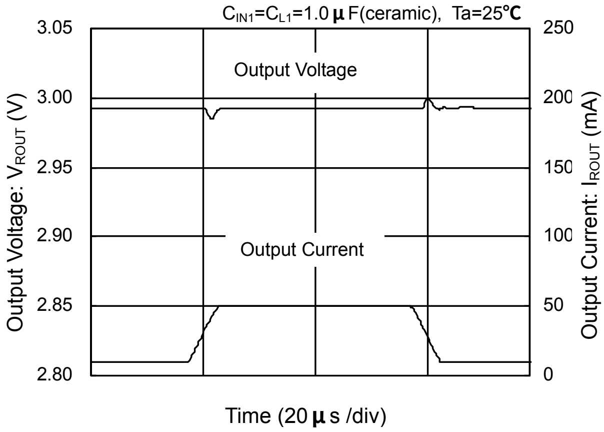
V_{ROUT}=2.5V

V_{IN1}=3.5V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃



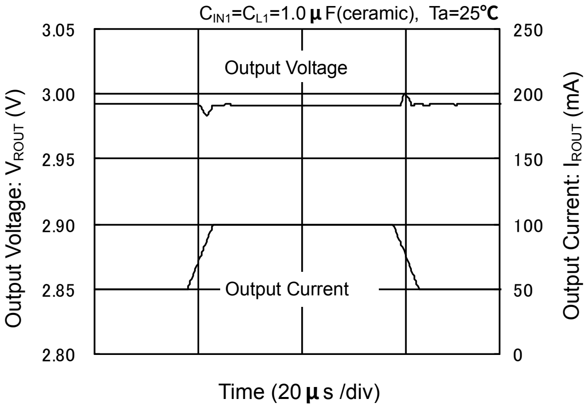
V_{ROUT}=3.0V

V_{IN1}=4.0V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃



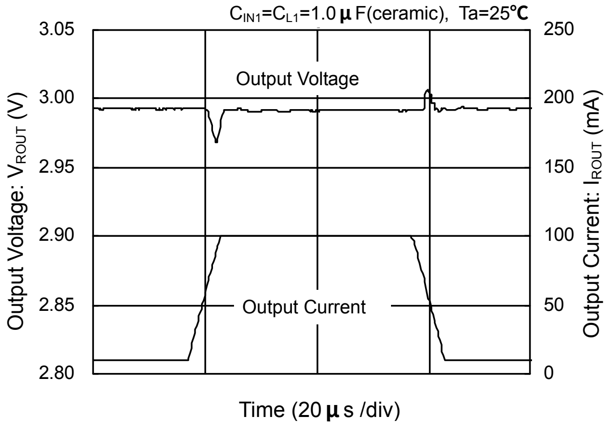
V_{ROUT}=3.0V

V_{IN1}=4.0V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃



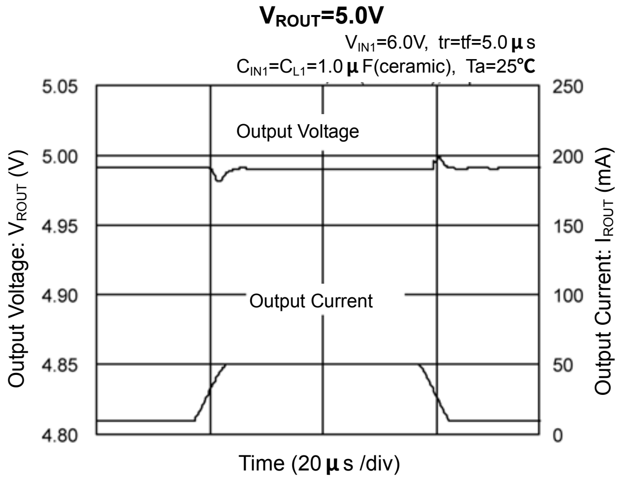
V_{ROUT}=3.0V

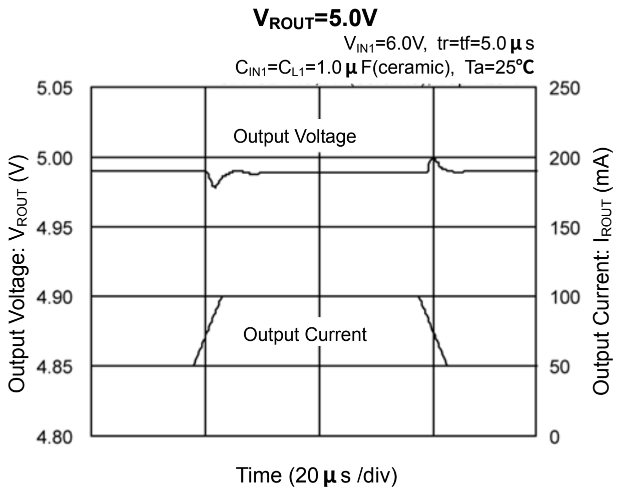
V_{IN1}=4.0V, tr=tf=5.0µs
C_{IN1}=C_{L1}=1.0µF(ceramic), Ta=25℃

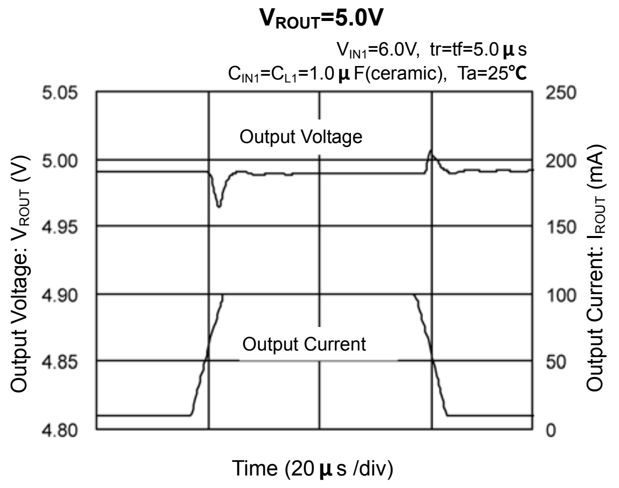


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(13) Load Transient Response (Continued)





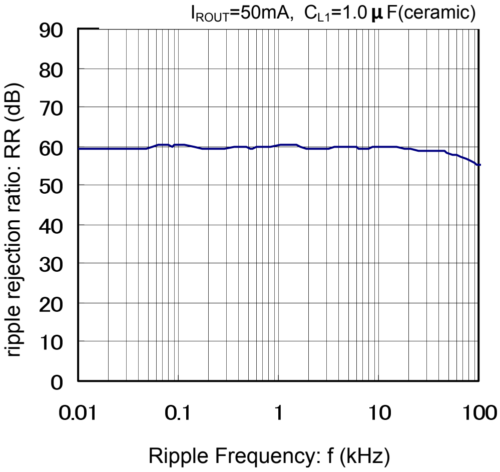


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(14) Ripple Rejection Rate

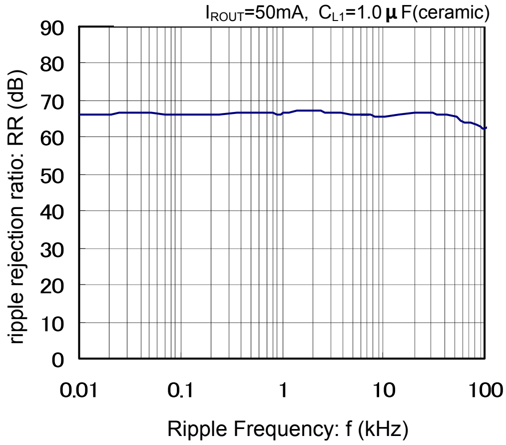
V_{ROUT}=0.9V

V_{IN1}=2.25VDC+0.5Vp-pAC
I_{ROUT}=50mA, C_{L1}=1.0μF(ceramic)



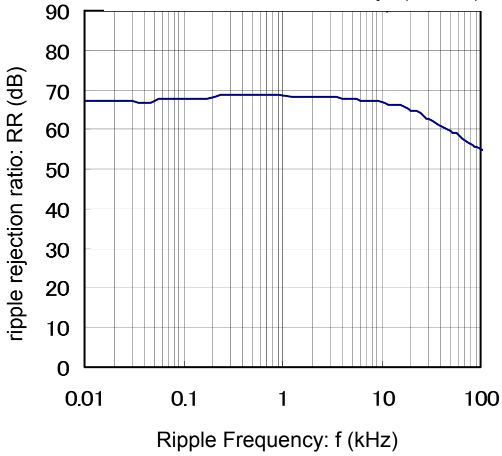
V_{ROUT}=1.8V

V_{IN1}=2.8VDC+1.0Vp-pAC
I_{ROUT}=50mA, C_{L1}=1.0μF(ceramic)



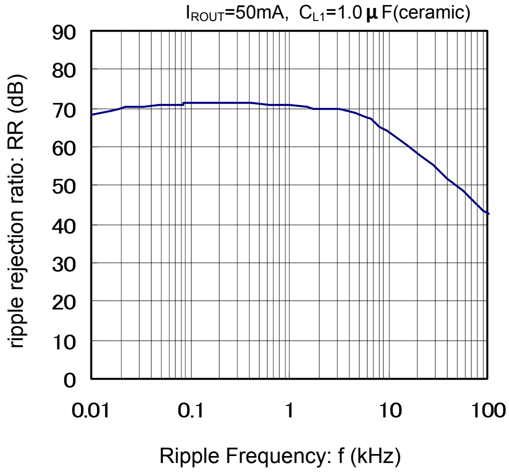
V_{ROUT}=2.5V

V_{IN1}=3.5VDC+1.0Vp-pAC
I_{ROUT}=50mA, C_{L1}=1.0μF(ceramic)



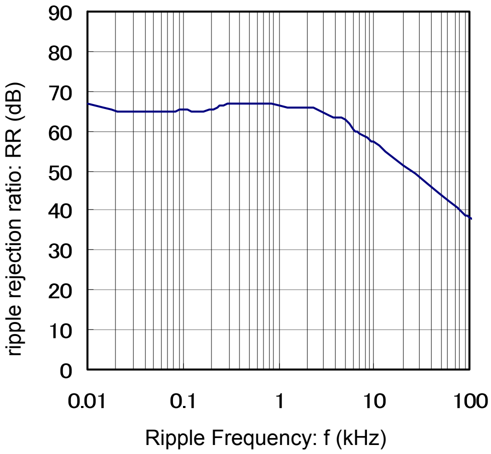
V_{ROUT}=3.0V

V_{IN1}=4.0VDC+1.0Vp-pAC
I_{ROUT}=50mA, C_{L1}=1.0μF(ceramic)



V_{ROUT}=5.0V

V_{IN1}=5.75VDC+0.5Vp-pAC
I_{ROUT}=50mA, C_{L1}=1.0μF(ceramic)

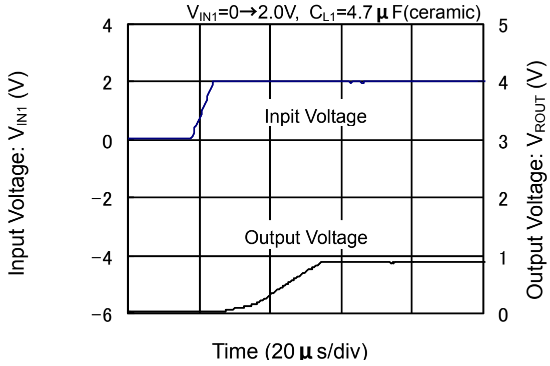


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(15) Input Voltage Rising Response Time

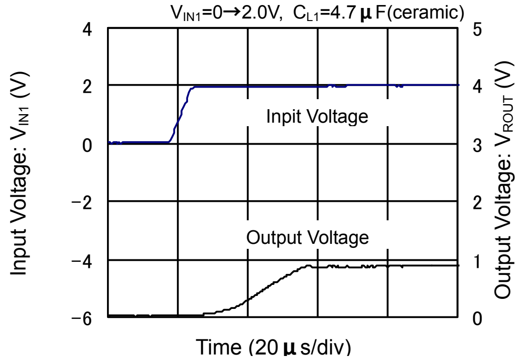
V_{ROUT}=0.9V

I_{ROUT}=1mA, tr= 5.0μs
V_{IN1}=0→2.0V, C_{L1}=4.7μF(ceramic)



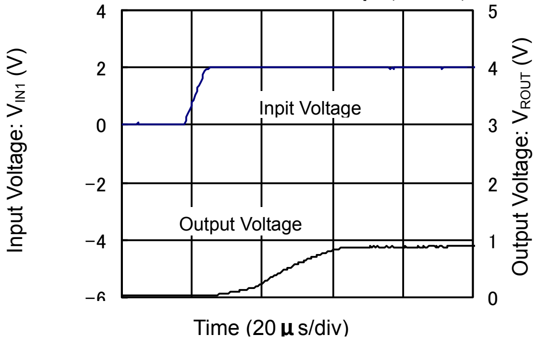
V_{ROUT}=0.9V

I_{ROUT}=30mA, tr= 5.0μs
V_{IN1}=0→2.0V, C_{L1}=4.7μF(ceramic)



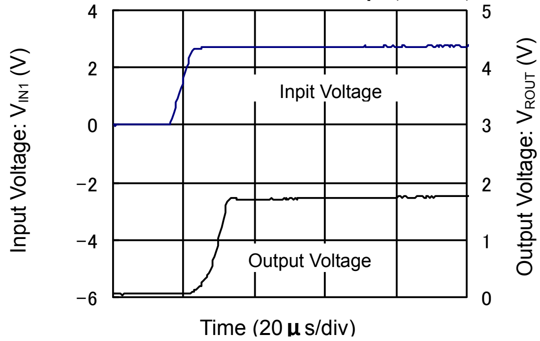
V_{ROUT}=0.9V

I_{ROUT}=100mA, tr= 5.0μs
V_{IN1}=0→2.0V, C_{L1}=4.7μF(ceramic)



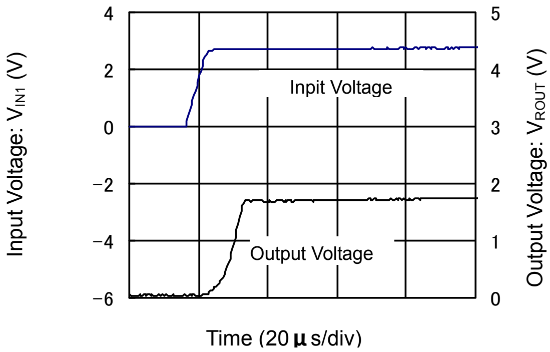
V_{ROUT}=1.8V

I_{ROUT}=1mA, tr= 5.0μs
V_{IN1}=0→2.8V, C_{L1}=1.0μF(ceramic)



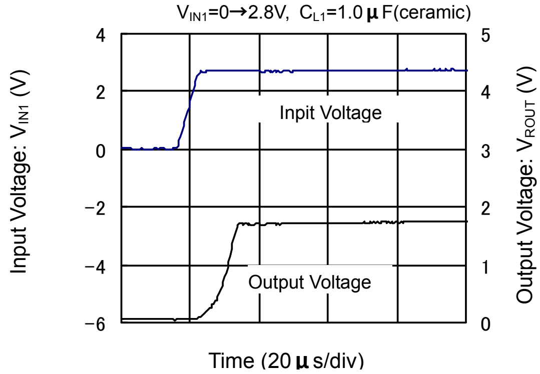
V_{ROUT}=1.8V

I_{ROUT}=30mA, tr= 5.0μs
V_{IN1}=0→2.8V, C_{L1}=1.0μF(ceramic)



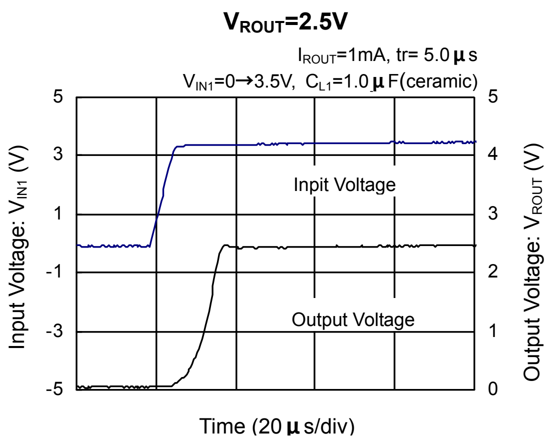
V_{ROUT}=1.8V

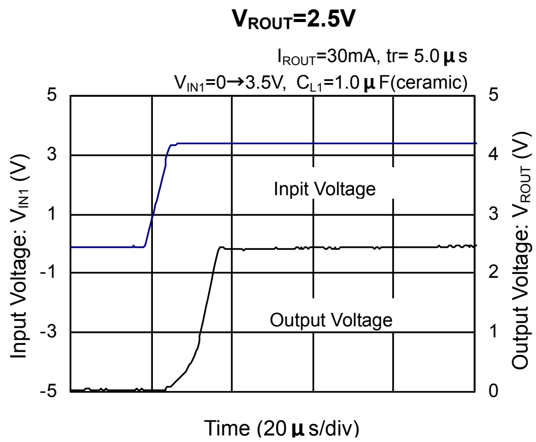
I_{ROUT}=100mA, tr= 5.0μs
V_{IN1}=0→2.8V, C_{L1}=1.0μF(ceramic)

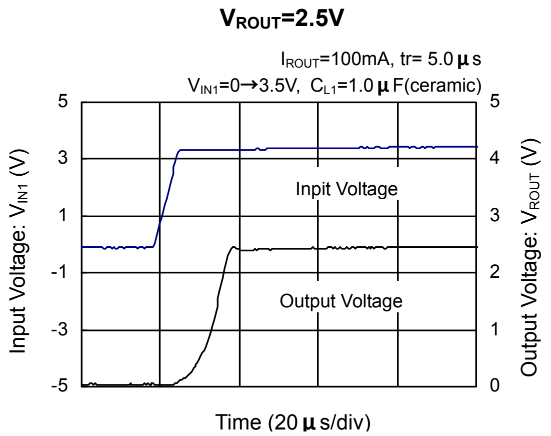


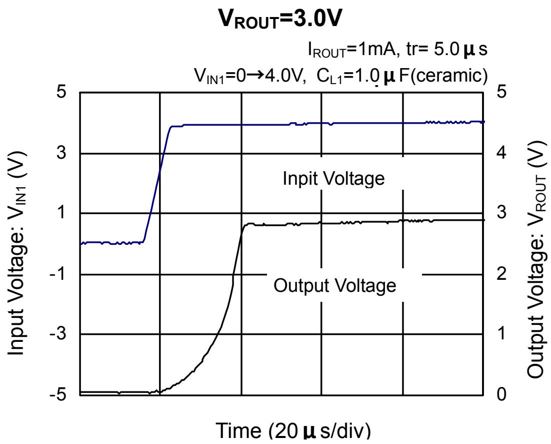
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

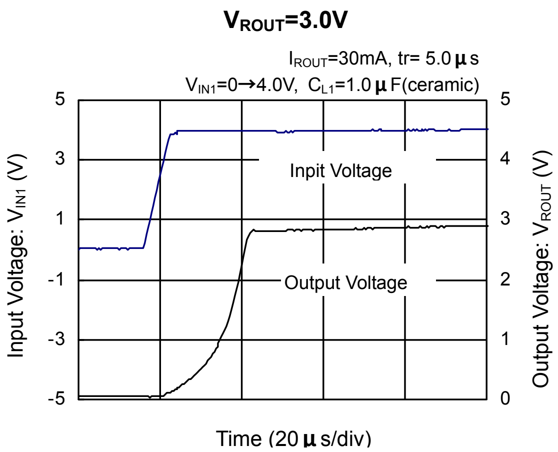
(15) Input Voltage Rising Response Time (Continued)

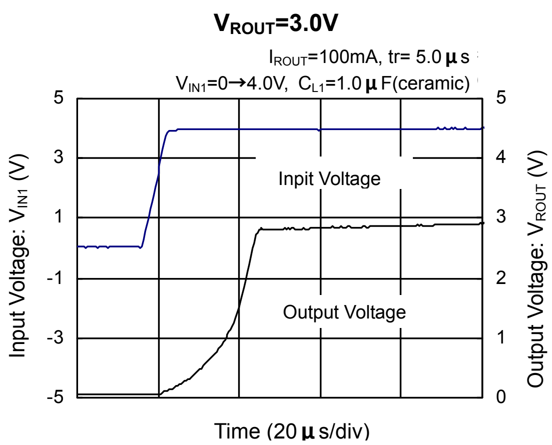






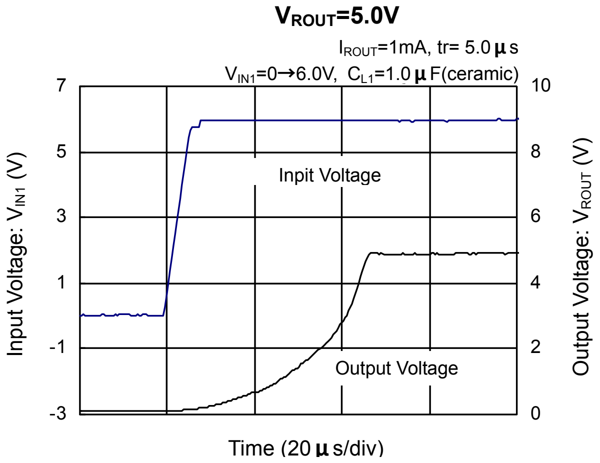


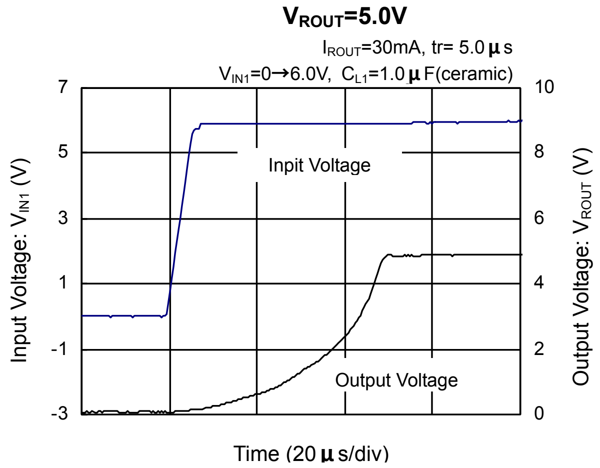


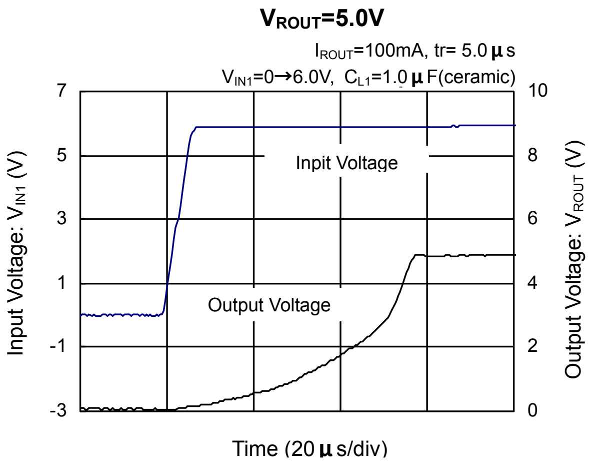


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(15) Input Voltage Rising Response Time (Continued)



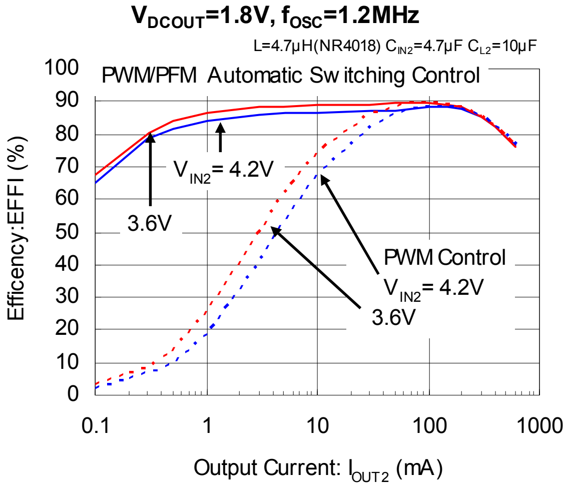


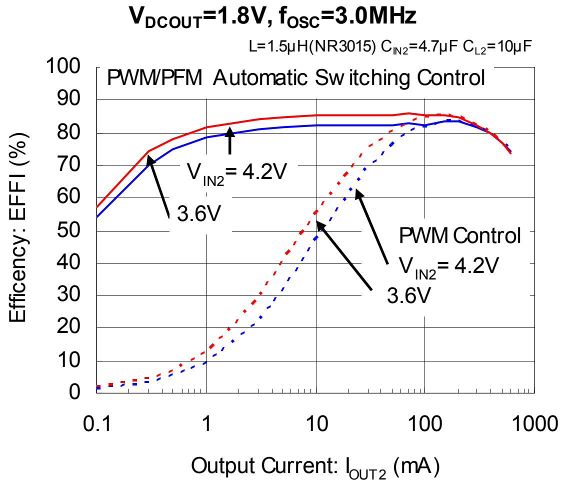


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

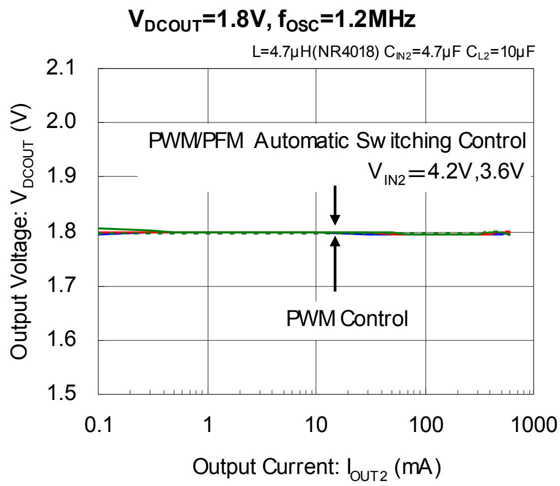
●2ch:DC/DC Convertor Block

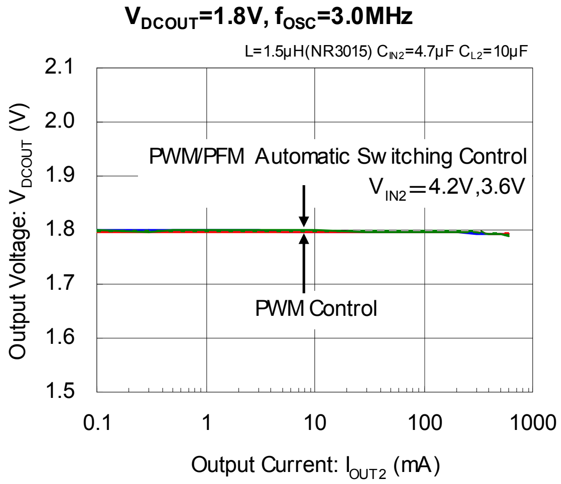
(1) Efficiency vs. Output Current



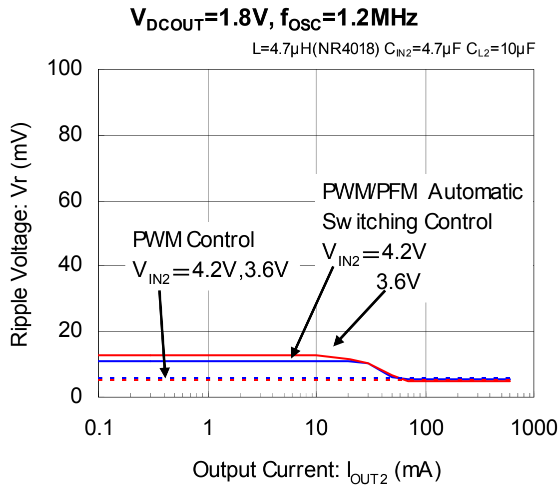


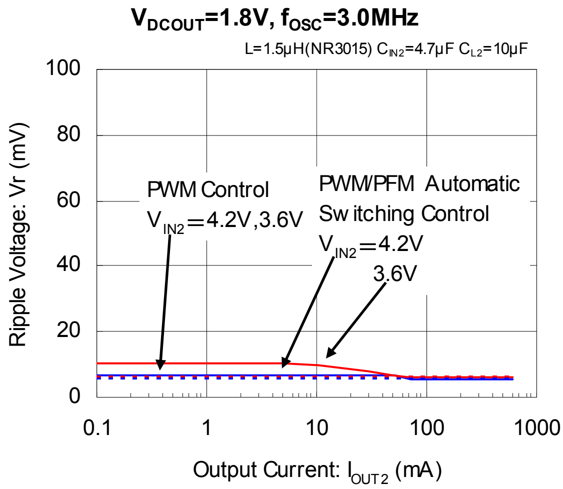
(2) Output Voltage vs. Output Current





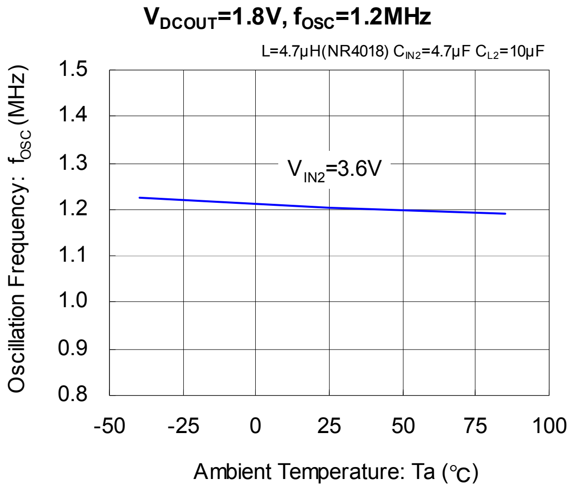
(3) Ripple Voltage vs. Output Current

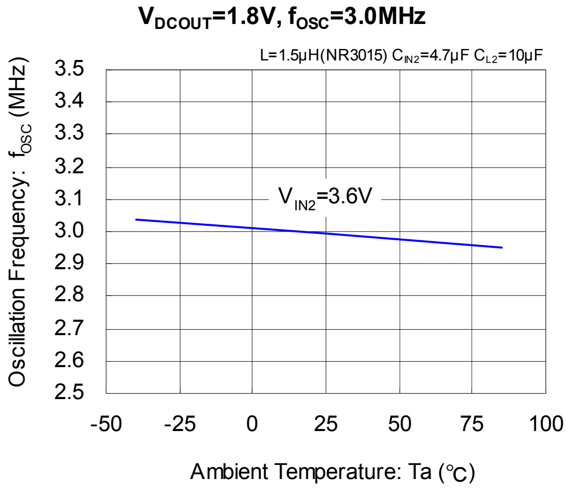




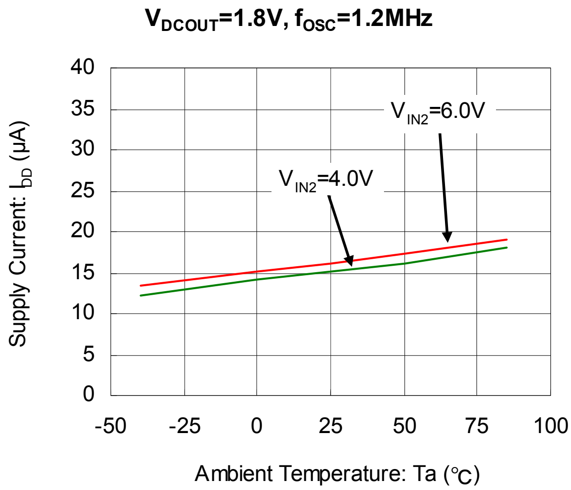
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

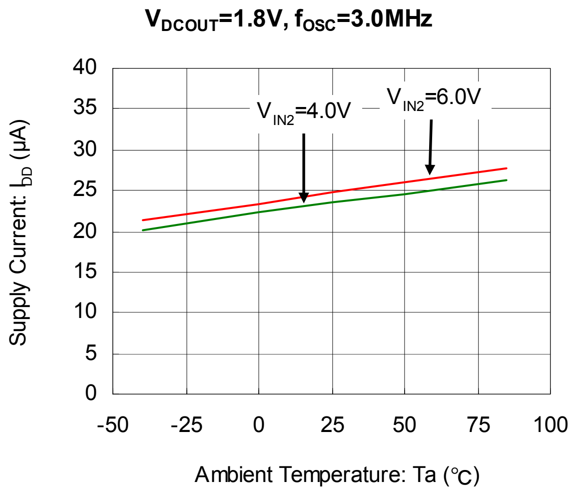
(4) Oscillation Frequency vs. Ambient Temperature



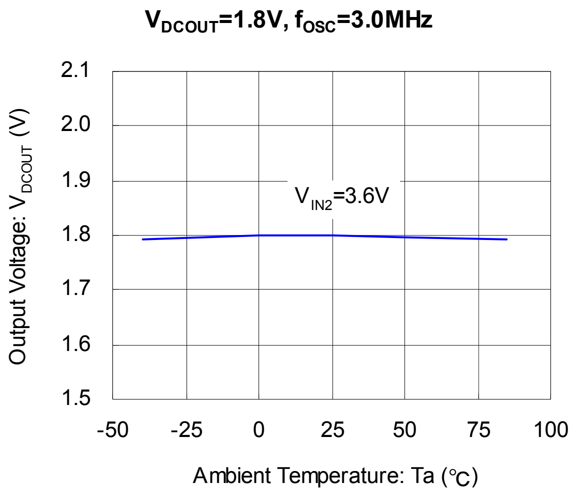


(5) Supply Current vs. Ambient Temperature

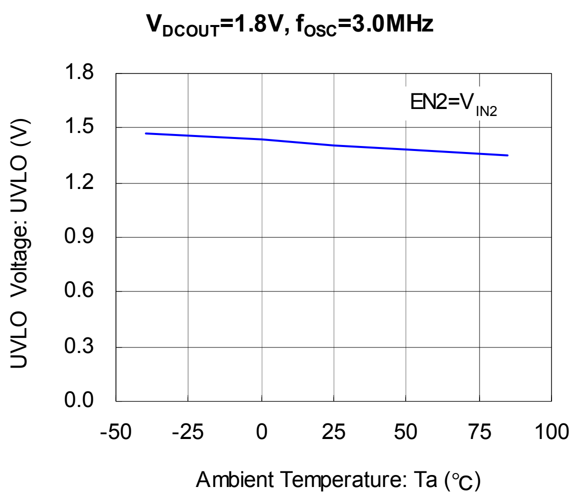




(6) Output Voltage vs. Ambient Temperature

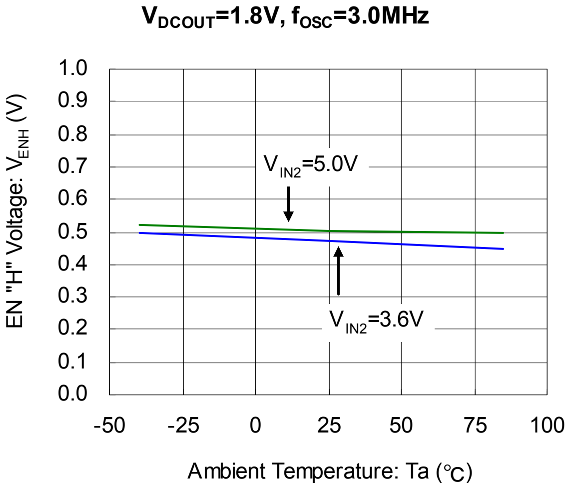


(7) UVLO Voltage vs. Ambient Temperature

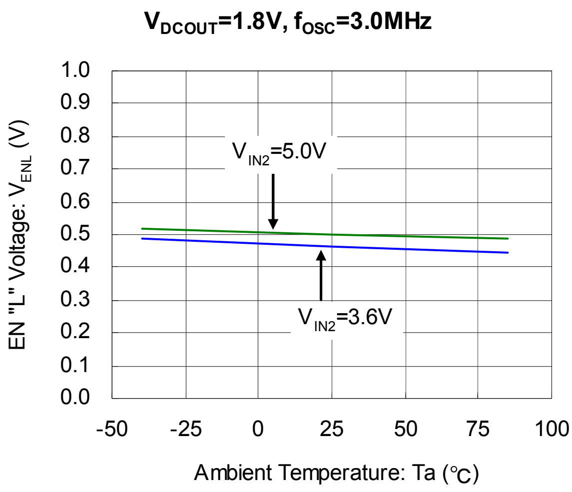


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

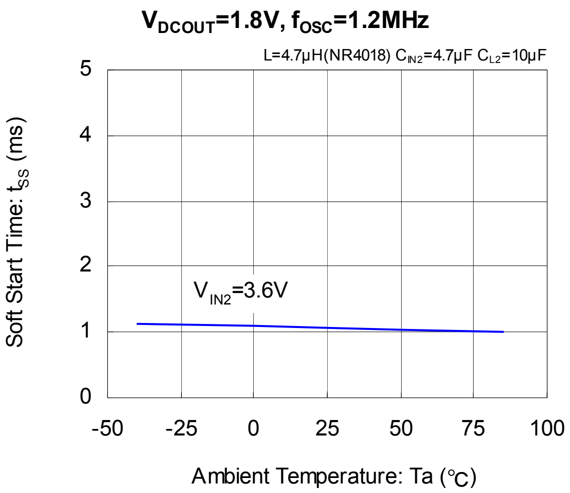
(8) EN "H" Voltage vs. Ambient Temperature

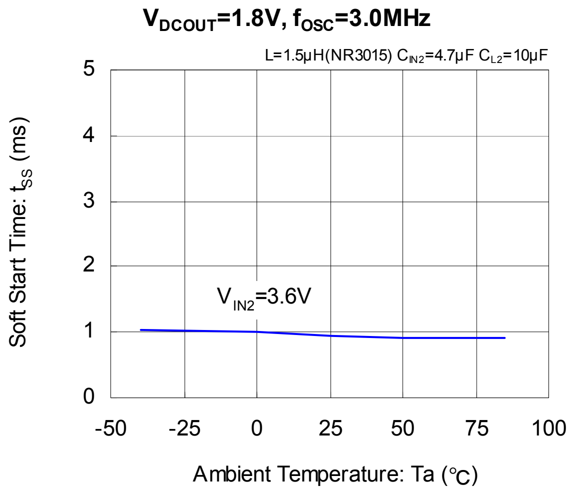


(9) EN" L" Voltage vs. Ambient Temperature

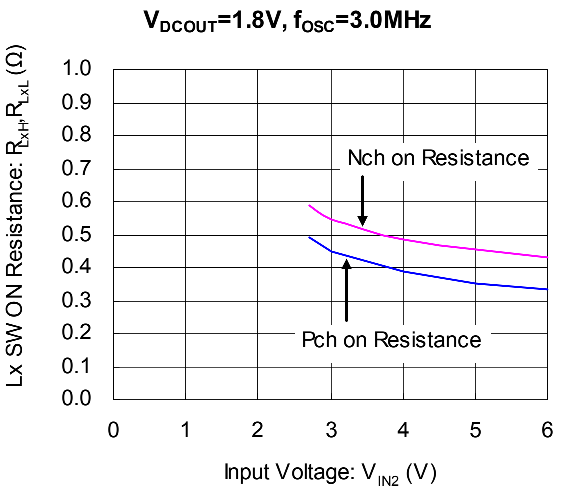


(10) Soft Start Time vs. Ambient Temperature





(11) "P-channel/N-channel" Driver on Resistance vs. Input Voltage

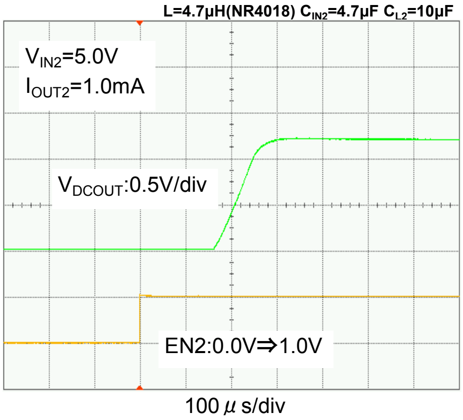


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(12) XCM524xC/ XCM524xD Series Rise Wave Form

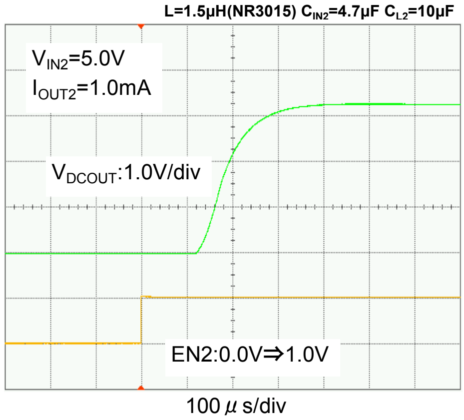
V_{DCOUT}=1.2V, f_{OSC}=1.2MHz

L=4.7μH(NR4018) C_{IN2}=4.7μF C_{L2}=10μF



V_{DCOUT}=3.3V, f_{OSC}=3.0MHz

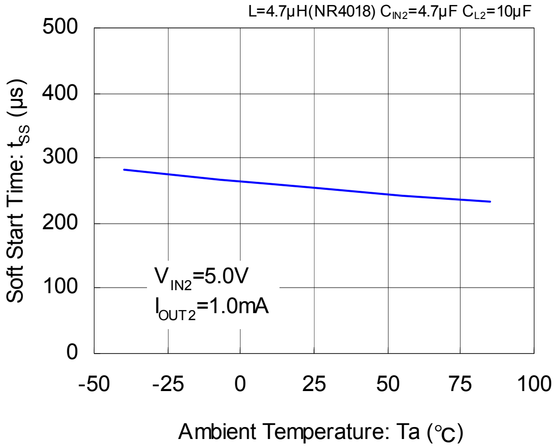
L=1.5μH(NR3015) C_{IN2}=4.7μF C_{L2}=10μF



(13) XCM524xC/ XCM524xD Series Soft-Start Time vs. Ambient Temperature

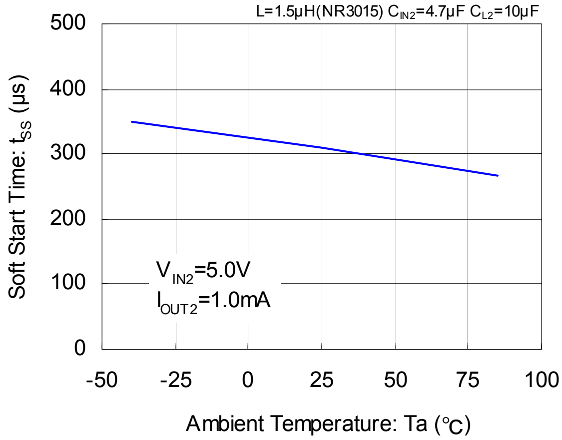
V_{DCOUT}=1.2V, f_{OSC}=1.2MHz

L=4.7μH(NR4018) C_{IN2}=4.7μF C_{L2}=10μF



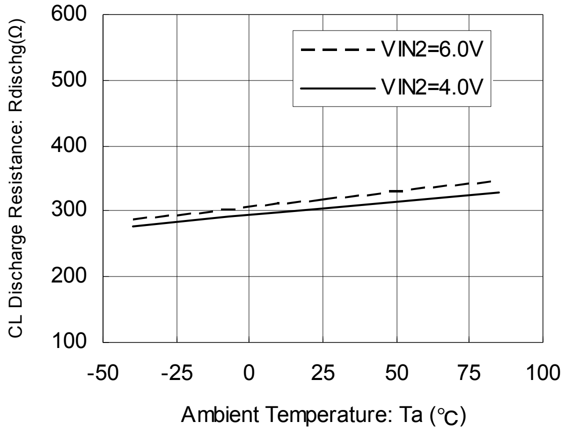
V_{DCOUT}=3.3V, f_{OSC}=3.0MHz

L=1.5μH(NR3015) C_{IN2}=4.7μF C_{L2}=10μF



(14) XCM524xC/ XCM524xD Series CL Discharge Resistance vs. Ambient Temperature

V_{DCOUT}=3.3V, f_{OSC}=3.0MHz



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

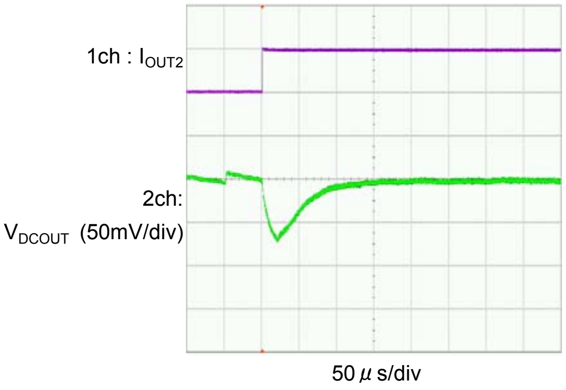
(15) Load Transient Response

V_{DCOUT}=1.2V, f_{OSC}=1.2MHz(PWM/PFM Automatic Switching Control)

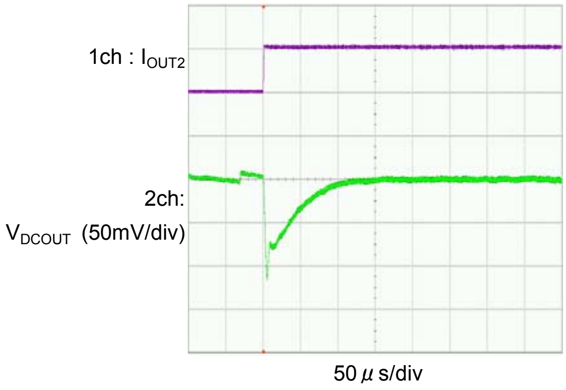
L=4.7μH(NR4018), C_{IN2}=4.7μF(ceramic), C_{L2}=10μF(ceramic), Ta=25℃

V_{IN2}=3.6V, EN2=V_{IN2}

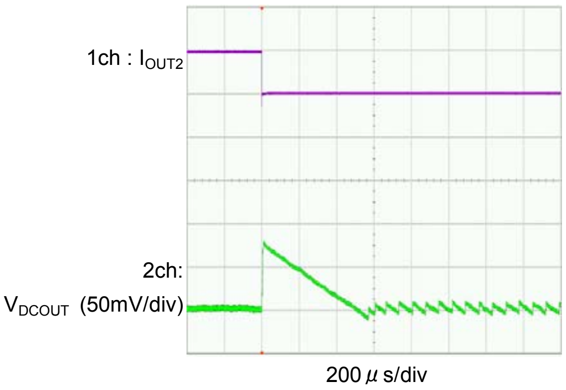
I_{OUT2}=1mA → 100mA



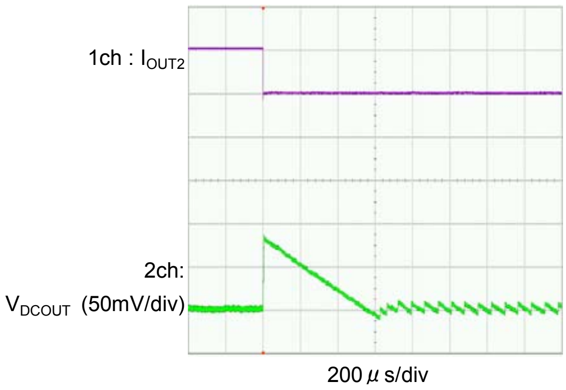
I_{OUT2}=1mA → 300mA



I_{OUT2}=100mA → 1mA



I_{OUT2}=300mA → 1mA



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

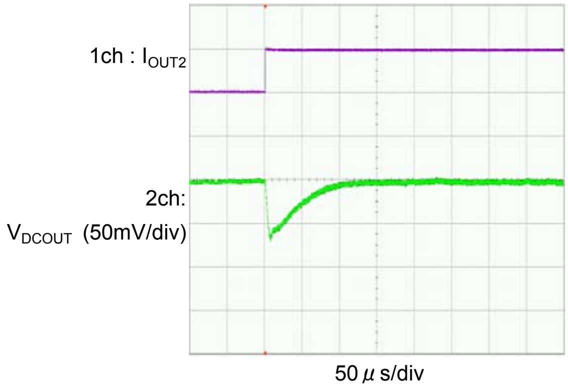
(15) Load Transient Response (Continued)

V_{DCOUT}=1.2V, f_{OSC}=1.2MHz (PWM Control)

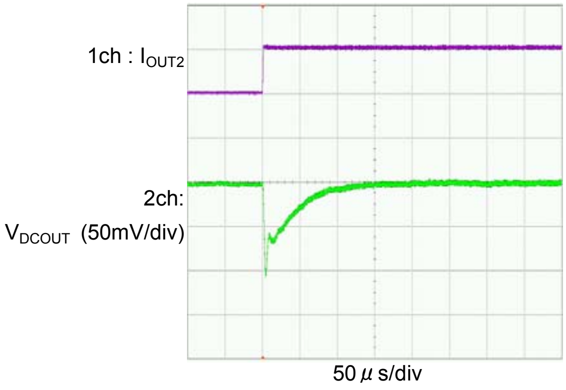
L=4.7μH(NR4018), C_{IN2}=4.7μF(ceramic), C_{L2}=10μF(ceramic), Ta=25℃

V_{IN2}=3.6V, EN2=V_{IN2}

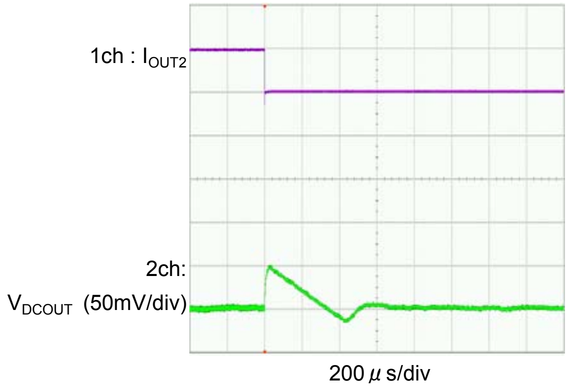
I_{OUT2}=1mA → 100mA



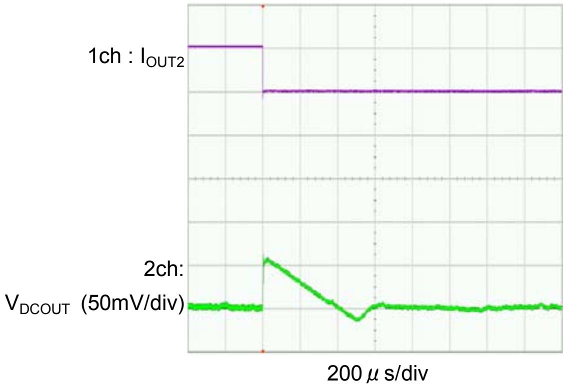
I_{OUT2}=1mA → 300mA



I_{OUT2}=100mA → 1mA



I_{OUT2}=300mA → 1mA



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

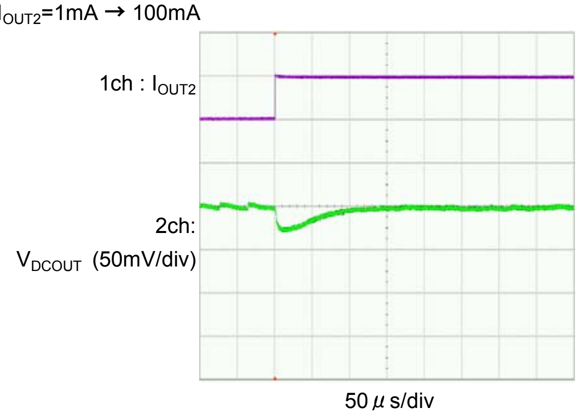
(15) Load Transient Response (Continued)

V_{DCOUT}=1.8V, f_{OSC}=3.0MHz (PWM/PFM Automatic Switching Control)

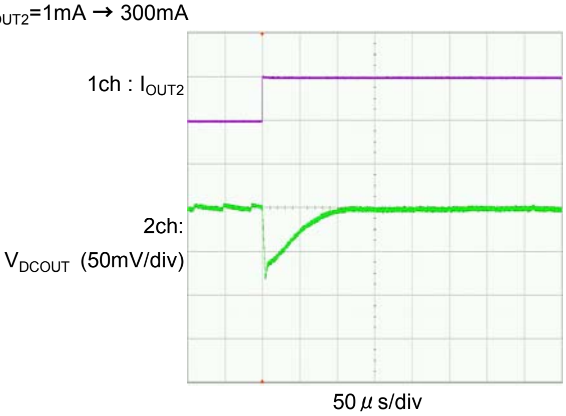
L=1.5μH(NR3015), C_{IN2}=4.7μF(ceramic), C_{L2}=10μF(ceramic),Ta=25℃

V_{IN2}=3.6V, EN=V_{IN2}

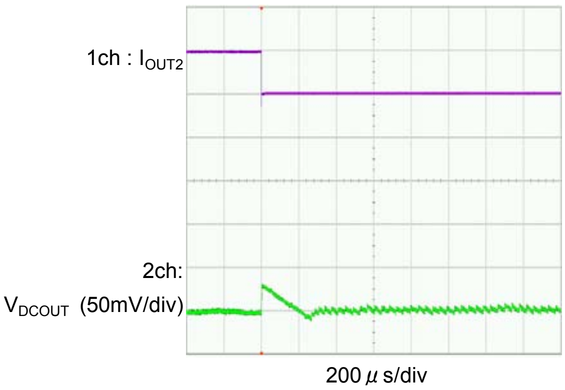
I_{OUT2}=1mA → 100mA



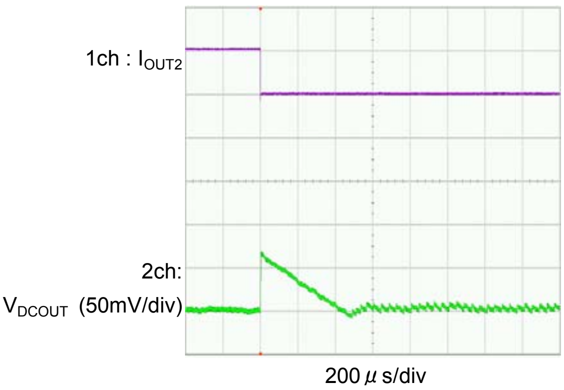
I_{OUT2}=1mA → 300mA



I_{OUT2}=100mA → 1mA



I_{OUT2}=300mA → 1mA



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

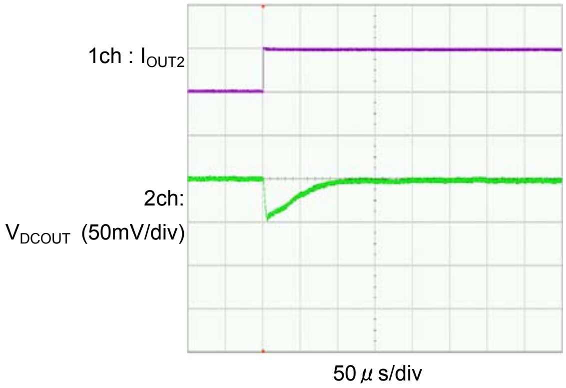
(15) Load Transient Response (Continued)

V_{DCOUT}=1.8V, f_{OSC}=3.0MHz (PWM Control)

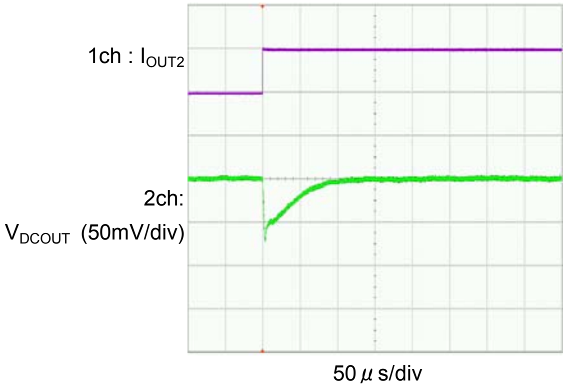
L=1.5μH(NR3015), C_{IN2}=4.7μF(ceramic), C_{L2}=10μF(ceramic), Ta=25℃

V_{IN2}=3.6V, EN2=V_{IN2}

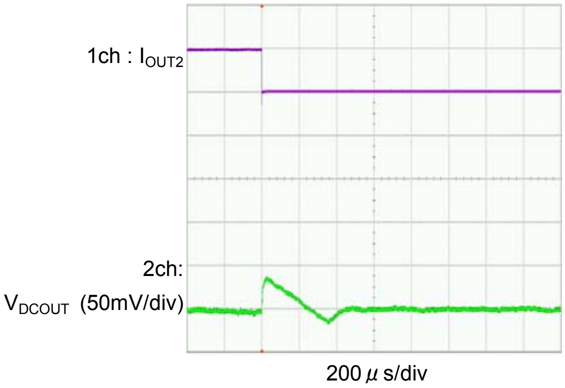
I_{OUT2}=1mA → 100mA



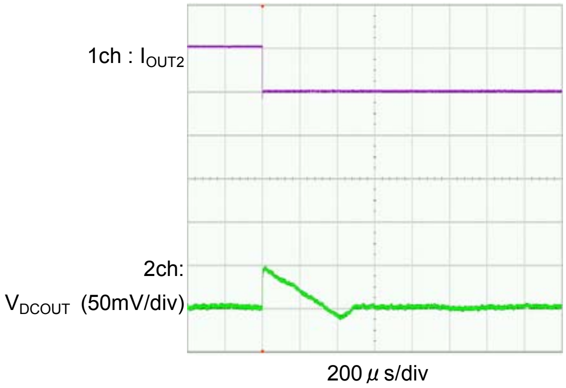
I_{OUT2}=1mA → 300mA



I_{OUT2}=100mA → 1mA

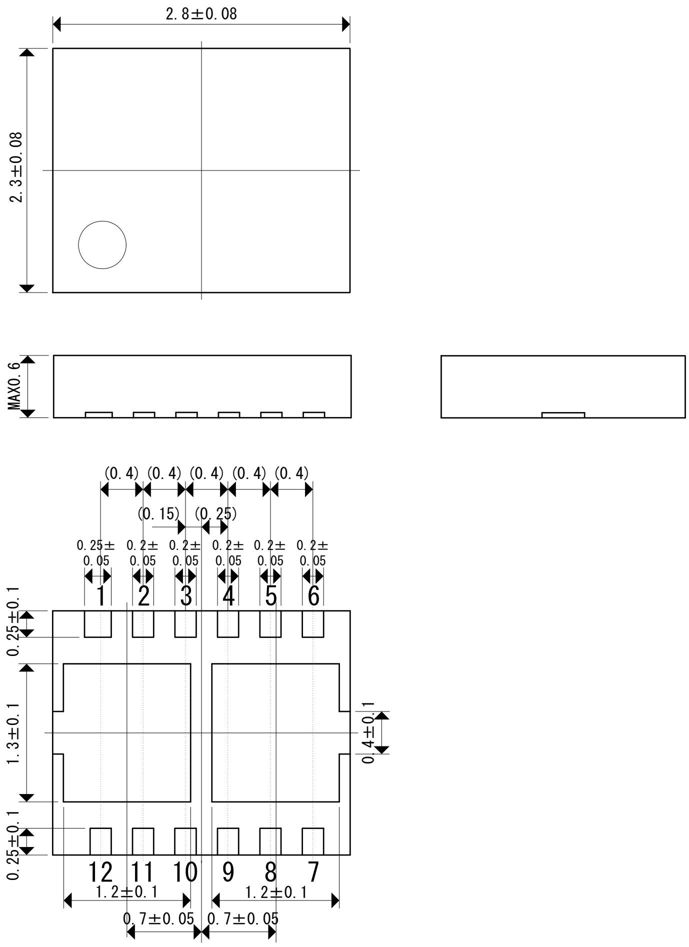


I_{OUT2}=300mA → 1mA

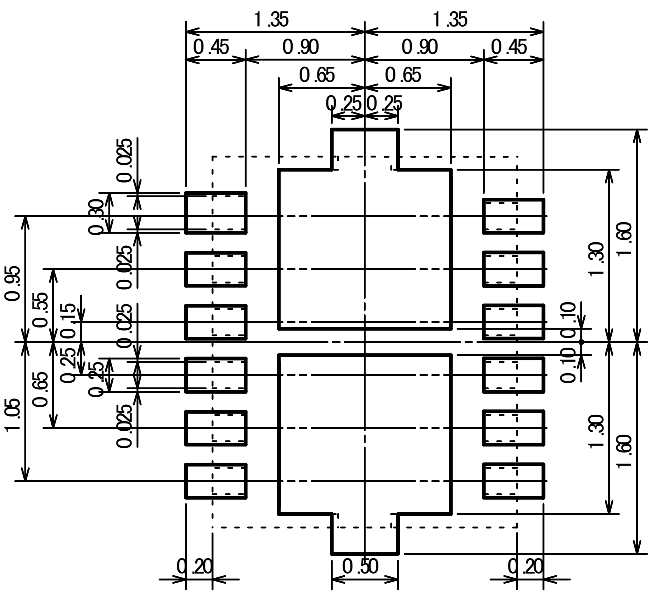


PACKAGING INFORMATION

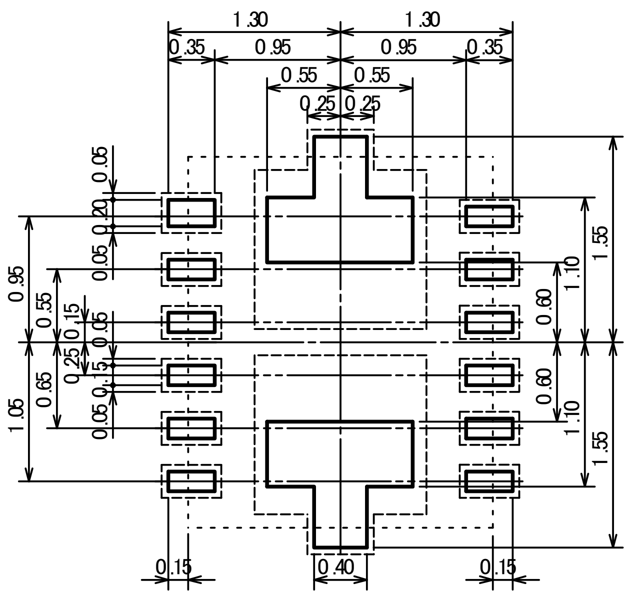
● USP-12B01



● USP-12B01 Reference Pattern Layout



● USP-12B01 Reference Metal Mask Design



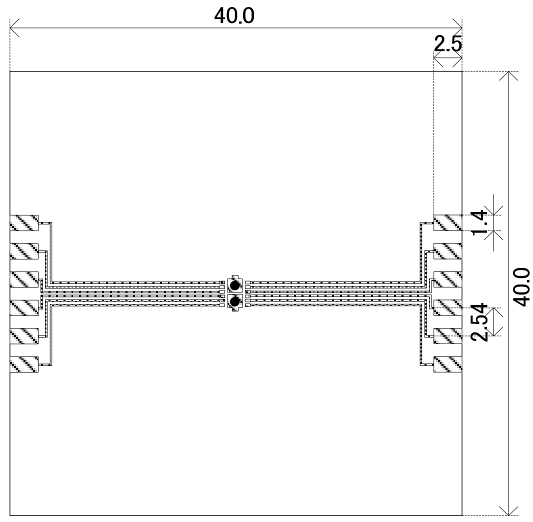
■PACKAGING INFORMATION (Continued)

● USP-12B01 Power Dissipation

Power dissipation data for the USP-12B01 is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as one of reference data taken in the described condition.

1. Measurement Condition (Reference data)

Condition: Mount on a board
Ambient: Natural convection
Soldering: Lead (Pb) free
Board: Dimensions 40 x 40 mm (1600 mm^2 in one side)
1st Layer: Land and a wiring pattern
2nd Layer: Connecting to approximate 50% of the 1st heat sink
3rd Layer: Connecting to approximate 50% of the 2nd heat sink
4th Layer: Noting
Material: Glass Epoxy (FR-4)
Thickness: 1.6 mm
Through-hole: 2 x 0.8 Diameter (each TAB needs one through-hole)

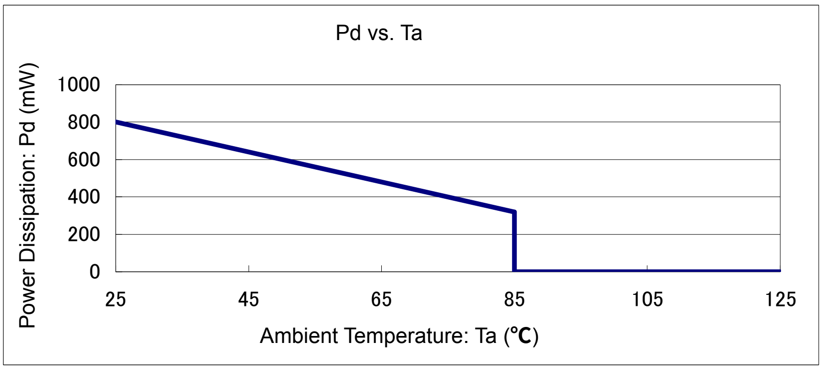


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

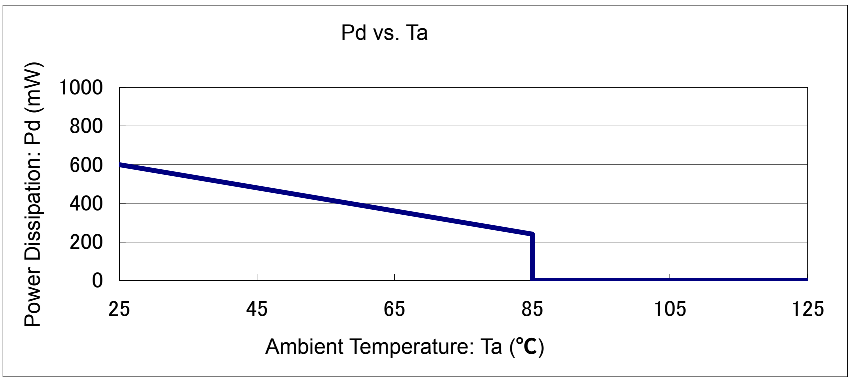
●Only 1ch heating, Board Mount (Tj max = 125℃)

Ambient Temperature(℃)	Power Dissipation Pd(mW)	Thermal Resistance (℃/W)
25	800	125.00
85	320	



●Both 2ch heating same time, Board Mount (Tj max = 125℃)

Ambient Temperature(℃)	Power Dissipation Pd(mW)	Thermal Resistance (℃/W)
25	600	166.67
85	240	



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